SCIENCE

VOL. 94 FRIDAY, JULY 4, 1941 No. 2427

The Study of Man: PROFESSOR L. J. HENDERSON 1

Obituary:

Charles Lloyd Connor: C. L. *Recent Deaths* 11

Scientific Events:

Retirement of Herbert P. Whitlock of the American Museum of Natural History; The Botanical Expedition to Guatemala of the Field Museum; The High School of Science in New York City; The Olin Hall of Chemical Engineering at Cornell University; The Public Health Research Institute of New York City; Meeting of the International College of Surgeons in Mexico City 11

Scientific Notes and News 14

Discussion:

Establishment of a Natural Area on the Huntington Wildlife Forest: PROFESSOR FRANK E. EGLER. *The Relation between Mental and Physical Development:* DR. WILLIAM S. CARLSON. *The Solar Radiation Constant and the Active Region on the Sun:* PROFESSOR FERNANDO SANFORD. *An Analysis of the Spread of Epidemics:* DR. HELGE PETERSEN 16

Scientific Books:

National Unity and Disunity: DR. E. L. THORNDIKE. *Temperature:* DR. ROBERT B. SOSMAN 19

The University of Chicago's Fiftieth Anniversary Symposia 20

Special Articles:

The Agglutination of Red Cells by Allantoic Fluid of Chick Embryos Infected with Influenza Virus: DR. GEORGE K. HIRST. *On the Specific Adsorption of Alcohols at the Salicylaldehyde Water Interface:* DRS. GÖSTA C. H. EHRENSVÄRD and DUDLEY F. CHEESMAN. *Experimental Vitamin P Deficiency:* DRS. ST. RUSZNYÁK and A. BENKÓ 22

Scientific Apparatus and Laboratory Methods:

Preparing Nitrate-Free Sea Water: PROFESSOR REX J. ROBINSON and BENJ. M. G. ZWICKER. *Smoothing Colors Applied by Colored Pencils:* H. T. GISBORNE 25

Science News 10

Index to Volume XCIII i

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

THE STUDY OF MAN[1]

By Professor L. J. HENDERSON

HARVARD UNIVERSITY

THE subject of this address is neither man nor the propriety or the appropriateness of the study of man; it is that study itself. It is not an examination of what chiefly interested Pope and Bolingbroke; it is a consideration of certain biological and social sciences. It is not even primarily the study of man; it is the study of men as organisms, of their structures and functions, in sickness and in health, and of men as persons, in their activities and their interactions; for the characteristics of man are but the uniformities observable among men. Again, our subject is not the examination of what such studies ought to be; it is merely a fragment of a description and analysis of what they are, of how they have been, and of how they have not been, effectively prosecuted. Let us note at once that effective work involves both doing what is effective and not doing what is not effective.

The study of men—even the scientific study—is ancient and respectable. It goes back to Aristotle, to Hippocrates and beyond them to obscure beginnings. To-day it is one of the chief studies of the learned. Like our other activities, it may be divided into two parts, the successful part and the unsuccessful part. Speaking very generally and with due regard to numerous and important exceptions, it may be said that the successful part of the scientific study of men is related to medicine, the unsuccessful part to philosophy and to the social sciences. These relations are not only historical, they are also to be seen in methods, attitudes and traditions.

The successes of medicine and the medical sciences have not been lightly won; from a multitude of failures

[1] An address delivered at the University of Pennsylvania Bicentennial Conference, September 18, 1940.

they are the survivals, the fortunate productions of the best or the most-favored men among an endless succession of skilful physicians. Though pedantry, incompetency and charlatanry have often hindered and in evil times, even for long periods, arrested the accumulations of medical science, since Hippocrates, at least, the tradition of skilful practice has never been quite lost—the tradition that combines theory and practice. And this tradition is, especially in three elements, indispensable.

Hippocrates[2] teaches first, hard, persistent, intelligent, responsible, unremitting labor in the sick room, not in the library: the all-round adaptation of the doctor to his task, an adaptation that is far from being merely intellectual. This is adaptation chiefly through the establishment of conditioned reflexes. Something like it seems to be a necessary part of the mastery of any material or of effective work in any medium, for such adaptation is the mark of every master-workman in every field. Galileo refers to it among artisans, saying:[3] "Indeed, I myself, being curious by nature, frequently visit [the arsenal of Venice] for the mere pleasure of observing the work of those whom, on account of their superiority over other artisans, we call 'first rank men.' Conference with them has often helped me in the investigation of certain effects including not only those which are striking, but also those which are recondite and almost incredible." A similar adaptation is not less evident in the most abstract of the sciences—in mathematics. What, indeed, can be done in mathematics by one who lacks complete intuitive familiarity with the symbols and operations of the science, by one who must constantly think of and be aware of what he is doing and how he is doing it?

Hippocrates teaches, secondly, accurate observation of things and events, selection, guided by judgment born of familiarity and experience, of the salient and the recurrent phenomena, and their classification and methodical exploitation. This is descriptive science. It is not necessary for the craftsman, it is for the scientist. The more complex the things studied by a science, the greater—in general—the importance of descriptive knowledge. For example, taxonomy is more important to zoology than description to mechanics. In the scientific study of men much systematic descriptive knowledge is almost everywhere indispensable.

Hippocrates teaches, thirdly, the judicious construction of a theory—not a philosophical theory, nor a grand effort of the imagination, nor a quasi-religious dogma, but a modest pedestrian affair, or perhaps I had better say, a useful walking stick to help on the way—and the use thereof. Theoretical science is not necessary for the craftsman, or, perhaps, for the descriptive scientist, because both may think in terms of the world of common sense. But theory in the form of some kind of an abstract conceptual scheme seems to be necessary for the effective exploitation of even descriptive science.

All this may be summed up in a word: The physician must have, first, intimate, habitual, intuitive familiarity with things; secondly, systematic knowledge of things; and thirdly, an effective way of thinking about things.

Experience shows that this is the way to success. It has long been followed in studying sickness, but hardly at all in studying the other experiences of daily life. Let us, therefore, consider more carefully what Hippocrates did and what he did not do. He was in reaction chiefly against three things: first, against the ancient, traditional myths and superstitions which still prevailed among the physicians of his day; secondly, against the recent intrusion of philosophy into medical doctrine; thirdly, against the extravagant system of diagnosis of the Cnidian School, a body of contemporary physicians who seem to have suffered from a familiar form of professional pedantry. Here Hippocrates was opposing a pretentious systematization of knowledge that lacked solid objective foundation; the concealment of ignorance, probably more or less unconsciously, with a show of knowledge. Note well that such concealment is rarely altogether dishonest and that it may be practiced in thorough good faith.

The social sciences to-day suffer from defects that are not unlike the defects of medicine to which Hippocrates was opposed. First, social and political myths are everywhere current, and if they involve forms of superstition that are less apparent to us than the medical superstitions of long ago, that may well be because we recognize the latter class of superstitions for what they are while still accepting or half-accepting the former class. Secondly, there is at least as much philosophy mingled with our current social science as there was at any time in the medical doctrines of the Greeks. Thirdly, a great part of the social science of to-day consists of elaborate speculation on a very insufficient foundation of fact.

Hippocrates endeavored to avoid myths and traditional rules, the grand search for philosophical truth, the authority of philosophical beliefs, the concealment of ignorance with a show of systematic knowledge. He was concerned first of all not to conceal his own ignorance from himself. When he thought abstractly, or in general terms, his thought was limited and con-

[2] In speaking of Hippocrates, I mean the author or authors of the so-called genuine works of Hippocrates, and wish to express no opinion about the man of that name, whose life is little known. We need here feel no concern for the question whether this man wrote these works.

[3] "Dialogues Concerning Two New Sciences," Macmillan, New York, 1914, p. 1.

strained because he had wide intuitive knowledge based on the habit of responsible action in concrete situations. There is a test for this kind of thinking: the question, "For example?" Those who generalize from experience almost always pass this test; others do not. Indeed, the test is frequently destructive of unfounded generalization and is apt to lead to painful embarrassment. For this reason its use is often inexpedient.

Experience shows that there are two kinds of human behavior which it is ordinarily convenient and often essential to distinguish:

The one is thinking, talking and writing, by those who are so familiar with relevant concrete experiences that they can not ordinarily forget the facts, about two kinds of subjects. These are: first, concrete observations, and observations and experiences which are representable by means of sharply defined or otherwise unambiguous words; and secondly, more general considerations, clearly and logically related to such concrete observations and experiences.

The other kind of behavior is thinking, talking and writing about vague or general ideas or "concepts" which do not clearly relate to concrete observations and experiences and which are not designated by sharply defined words. On the whole, the works of Plato belong to this second class, the Hippocratic writings to the first class.

The so-called genuine works of Hippocrates reveal a method in the exploitation of everyday experiences with the lives and deaths of men that can never be too carefully studied. In the beginning are the cases, the clinical records of the great physician. They consist of bare observations of bare facts, uncolored by theory or presupposition and condensed to the very limit of possible condensation. These are the practicing physician's data, freed so far as possible from everything that is not a datum. The data are of two kinds: the first kind, often contained in the first part of the record, are single observations; the second kind, commonly presented at the end, are observations of uniformities throughout a particular sickness of a particular person.

The next step, after the recognition of uniformities in a particular case, is the recognition of a wider kind of uniformity: the recurrence again and again in different cases, often otherwise very various, of single events or of the uniformity observed within a single case, for example: regularities in the duration of certain fevers, the frequent discharge of fluid through the nose in what we now call diphtheria, and in general the prognostic importance of a wide range of symptoms. The most famous of all the descriptions of such uniformities is that known as the "facies Hippocratica," the appearance of the face at the point of death in many acute diseases: "Nose sharp, eyes hollow, temples sunken, ears cold and contracted with their lobes turned outwards, the skin about the face hard and tense and parched, the colour of the face as a whole being yellow or black."

Throughout a great part of his work Hippocrates is thus moving step by step toward the widest generalizations within his reach. In great part he is seeking a natural history of acute disease, or at least of those acute diseases that were prevalent among his patients. His success was great, and the whole history of science goes far to support the view that such a methodical procedure is a necessary step in the development of a science that deals with similarly complex and various phenomena.

Beyond this stage there is one even wider generalization that plays an important part in the writings and thought of Hippocrates. This is the principle that came to be known, and is still remembered, as the *vis medicatrix naturae*. It may be stated in modern form as follows: Organisms exist in a state such that when a modification, not too great and different from what will otherwise occur, is impressed on them, a reaction appears tending toward the condition that would have existed if the modification had not been impressed. This is by no means only true for organisms, and indeed it has been more clearly recognized in recent years by certain economists in their theoretical studies than by physicians and physiologists.

In order to construct a useful conceptual scheme, Hippocrates proceeded to analyze this process, as he abstractly conceived it, into elements. His analysis and the resulting elaboration of the theory need not detain us. To them we owe the survival of such words as "crisis" and "coction." But the theory, having served its purpose, is obsolete, like Ptolemy's astronomy.

We must, however, note carefully that this obsolete theory, like so many others, once served its purpose well. In particular, it was the firm support of the Hippocratic principle of expectant treatment and of the precept "Do no harm," a principle and a precept which still preserve their utility in the practice of medicine and even in government and the affairs of everyday life, and which are too often disregarded by physicians, surgeons and politicians.

The Hippocratic conceptual scheme suffers from one particular defect that should be carefully noted: It presents a view of the physiological system in a state of equilibrium, without giving a satisfactory picture of the constituent parts of the system or of the forces that operate between these parts. We now know that it is convenient and reasonably satisfactory to think of the constituent parts as chemical substances, fluids, cells, tissues and organs; and of the forces as the forces with which theoretical physics and theoretical

chemistry are concerned. Such a conception was not available to Hippocrates. Nevertheless, his conceptual scheme worked and for a long time worked well. This is, in fact, the test of a conceptual scheme and the only test: it must work well enough for the purpose of the moment. A conceptual scheme survives just so long and just in so far as it continues to be convenient to use it for the purpose of scientific work.

In a discussion of scientific hypotheses, Henri Poincaré once remarked:[4] "These two propositions, 'the external world exists,' or 'it is more convenient to suppose that it exists,' have one and the same meaning." The proof of Poincaré's assertion is that in scientific work no use can be made of the proposition "the external world exists" that can not just as well be made of the statement "we assume for the present purpose that the external world exists." Moreover, all our conceptual schemes are in a state of flux. There is hardly one we now use that was used in precisely its present form fifty years ago. It is therefore dangerous to believe that a conceptual scheme is a description of some ultimate metaphysical reality. In other words, belief in the "truth" of a conceptual scheme is for scientific purposes not only irrelevant, it is often misleading.

Our modern theory and our modern practice of medicine are so different in so many ways from ancient theory and practice that only by an effort of thought and imagination can we clearly conceive what ancient medicine was. I have tried to suggest that its merits were great and to specify the nature of some of these merits. To specify its deficiencies is almost unnecessary. However, we may note that until long after the time of Hippocrates experiment was but a feeble aid to observation and that applications of physics and chemistry were altogether lacking because there was nothing to apply.

In our modern period all this is changed. The sciences of anatomy, physiology and pathology, with their many branches, have grown up. They have become experimental sciences and they are becoming more and more sciences of applied physics and applied chemistry. This development has been accompanied by the growth of a conceptual scheme in which the broader generalizations of the medical sciences are incorporated and synthesized.

But it is still true that the investigator must have intimate, habitual, intuitive familiarity with the things that he studies, systematic knowledge of them and an effective way of thinking about them. This is just as true in the anatomical laboratory or the physiological laboratory or the pathological laboratory as it is in the clinic. There is, I believe, no broader induction from our experience of scientific work than this, and few inductions are more important.

The present state of the medical sciences, and indeed of each one of their many principal branches, is the accumulated result of innumerable experimental researches and descriptive studies. In general, each of these departments of science has grown up through the concerted labors of hundreds or thousands of intelligent specialists working with methods that are a part of their professional skill and that are more or less common to them all, working also with a conceptual scheme with which all are familiar. This aggregate of theory, like the methods, evolves and adapts itself to the state of the science produced by the work that has already been done. There is reason to believe that these are necessary conditions for the development of any science and, above all, for any science that deals with very complex phenomena. At all events, there seems to be no example of a highly developed science that is not the product of the labors of many men working skilfully in parallel and in succession with methods, systematic descriptions and classifications that they share. In the early stages of a science the theories are crude and the classification simple. They grow by trial and error and by adaptation into more refined theories and more complex descriptions. In short, the growth of the medical sciences, like that of all sciences, was not planned. That which survives does so because it is adapted to the needs of the scientists. In the development of a science facts when well established are always adaptations. On the other hand, theories and classifications survive, as Mach long ago pointed out, largely because they economize thought and effort, perhaps in some measure, also, because they are felt to possess what mathematicians call elegance.

There are certain deficiencies of the medical sciences to which little attention has been devoted, partly because they are inevitable in sciences that have grown up as these have grown up, partly because of the immense success that has been achieved by doing things as they have long been done, partly because of the peculiar difficulties involved in working effectively to remedy these deficiencies, and partly because such work is different in kind and in method from most of the work to which investigators are accustomed. These deficiencies depend upon the fact that living organisms are immensely complex and that the experimental sciences, by hook or by crook, analyze the concrete reality into relatively simple elements. But the complex reality is never describable by merely adding up these elements, for they exist in a state of equally complex interaction. In a man, as in a machine, effective description involves both a knowledge of the parts and a knowledge of how these parts interact. Moreover, in organisms not only are the parts very numer-

[4] "La valeur de la science," Paris (no date), p. 272.

ous but their interactions are especially numerous. Indeed, many biological adaptations consist precisely in the establishment of new interactions between parts.

Consider the case of hemoglobin. This substance is the sole carrier of oxygen, apart from merely dissolved oxygen, in the blood. Many years ago the conditions of the equilibrium governing the combination of oxygen with hemoglobin were satisfactorily determined. It was then discovered that the affinity of hemoglobin for oxygen is modified when the pressure of carbonic acid, or the alkalinity of the blood, or any one of several other things varies. Next, it appeared that the interaction between oxygen and carbon dioxide, previously unsuspected but revealed by this discovery, greatly enhanced the efficiency of the blood as a carrier of both oxygen and carbon dioxide. In short, this interaction is an adaptation. Finally, it became possible to piece the facts together with the help of mathematical methods and to describe the interaction quantitatively.

The problem of describing the interaction between these two substances in blood was in certain respects a different problem, involving different procedures, from the problems involved in the earlier studies. In particular, it was a problem that could be solved only by the use of certain mathematical procedures appropriate to the treatment of a system in which several factors in a state of mutual interaction are involved. This is a simple case and a mere partial description of almost any interaction in biological systems presents far greater difficulties, yet even here the difficulties were great enough to make the use of special mathematical methods necessary.

When we possess adequate knowledge of a system in which n factors are involved and have arrived at a description of this system in terms of the n factors, so that their interactions are also described, it is possible to reason successfully concerning changes in the state of the system in so far as these n factors alone are concerned, to a given approximation, in the process that is being studied. But when a further factor is also involved our reasoning can never be trusted and is in general illusory. It is perhaps partly for this reason that anatomists, physiologists and pathologists do not practice medicine, and this is probably the principal source of the familiar attitude of suspicion toward the laboratory sciences that may be seen among experienced clinicians. When men reason deductively about the complex affairs of everyday life they nearly always leave out something, or rather many things, both things they forget and things they don't know. More often than not their conclusions are therefore unsound. This is what Whitehead calls "the fallacy of misplaced concreteness." I am not sure that it can be appreciated by any one who has not experienced the difficult task of putting together the pieces obtained by analytical studies and thus building up an adequate description of a system in which many factors interact. Experience alone can teach most people the immense complexity of interactions between many factors, and the mathematical solution of such problems seems to be the only means of clearly conceiving the nature of such phenomena. However, it may be well to consider a simple illustration.

The fallacy of misplaced concreteness is very common in the form of arguments involving "other things being equal." Suppose one is concerned with the correlation between values of two variables, say, x and y. Suppose, further, that it is assumed either that nothing else need be considered or that, other things being equal, this correlation must have a single value. In order to fix our ideas, let the case be such that the unknown relations between x, y, and the other things can be expressed by the equation

$$y = \frac{x+z}{x+2}$$

in which the value of z is a measure of the other things, say, u, v, w, or in other words z is a function of these other things, that is, z varies when either u or v or w varies.

Let us now give z successively the three values 1, 2 and 3. Then:

$$(1) \qquad y = \frac{x+1}{x+2}$$

$$(2) \qquad y = \frac{x+2}{x+2}$$

$$(3) \qquad y = \frac{x+3}{x+2}$$

These equations are represented graphically on Fig. 1.

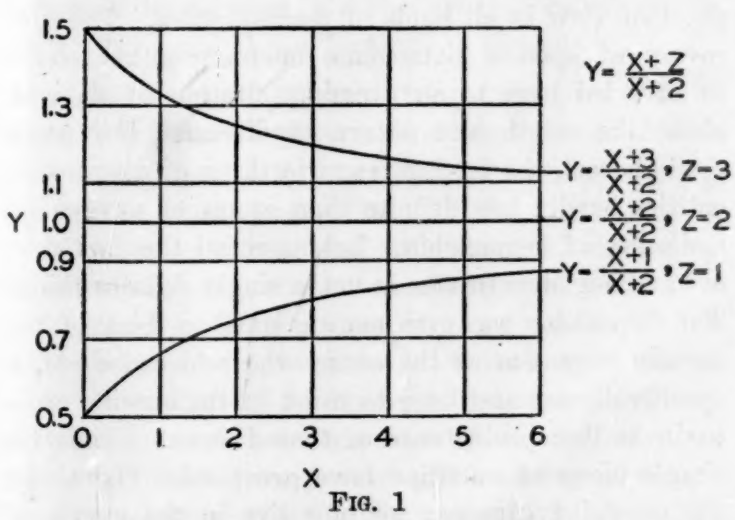

FIG. 1

Evidently when $z=1$, x and y are positively correlated; when $z=2$, they are independent, for y is constant while x varies; when $z=3$, they are negatively correlated. Accordingly, any statement about the correlation of y with x must take account of what happens when z varies or must specify the value of z at which other things are equal. But z is a function of

u, *v* and *w*, which makes for further complications. In general, it may be said that all arguments involving such notions as other things being equal, or *pari passu*, are probably fallacious except when the universe of discourse is arbitrarily limited by abstraction, as in mathematics and theoretical science. There is never any reason to suppose that until the conclusions have been well tested such reasoning can be safely applied to the complex reality of daily life, especially in that part of reality with which either the medical sciences or the social sciences are concerned.

Imagine two men setting to work, one on January 1, the other on July 1, to measure the duration of daily sunshine. Each might well find after three or four months a high correlation between time (*i.e.*, date) and duration of sunshine. But the first would observe a positive correlation, the second a negative correlation. Neither would be likely to deceive himself on this account, *because he has intuitive familiarity with the things in question and systematic knowledge thereof*, but if he were dealing with a like result from the study of unfamiliar phenomena he would probably fall into error, unless he appreciated the danger of the fallacy of misplaced concreteness.

The medical sciences have suffered and continue to suffer from this fallacy. The rise of bacteriology and its influence upon medical thought and practice may be taken as an example. About the time of Pasteur's first discoveries, the thought of Claude Bernard and of other physiologists seemed to indicate a movement toward the study of the interrelations between many things and a recognition of this kind of study, synthetic physiology, as one of the foundations of the medical sciences and as the source of an indispensable point of view in all kinds of medical work. The discovery of specific pathogenic microorganisms seems to have led back to an oversimplification of thought about the origin and nature of disease. For some time at least, the tendency was to think of diseases as entities hardly less definite than atoms of oxygen or molecules of hemoglobin. Let us recall the fact that even hemoglobin *in situ* is not a single definite thing. The disposition was even more marked to think of the specific organism as the cause—the sole cause—of a specific disease and later to think of the specific antitoxin as the specific cure of that disease. Similarly, simple views of nutrition have prevailed. There was the epoch of calories; we now live in the epoch of vitamins. Hormones also are now having their day, and excess or deficiency of specific hormones, like excess or deficiency of particular vitamins, is often thought of as the cause of a specific disease.

All this oversimplified thinking has flourished and survived because up to a certain point it is convenient. In bacteriology and in chemical physiology it is more than this; it is probably necessary, for it affords the simplest possible conceptual scheme useful for certain purposes. Its usefulness is like that of Boyle's law for gases—volume varies inversely as pressure—which is true only approximately and only with important restrictions.

Indeed, nothing is more convenient than to be able to think of a phenomenon as simple, of its cause as single, and to feel that, accordingly, there is but one clear, straight path to be followed in action. This is just the kind of situation that satisfies men of action, who are fortunately numerous among doctors, and there is nothing about the growth of medicine in recent years that is more important or that has, upon the whole, contributed more to the relief of suffering and the cure of sickness than the increase in the number of pathological conditions, complex though they are in reality, that may be regarded as mere cases of a particular disease caused by a single cause and curable by the use of a single remedy. Perhaps nothing in modern medicine would have seemed so strange as this to Hippocrates.

The disposition to think in this manner has also been strengthened both by the influence of the conditions of modern life upon the practice of medicine and by increasing specialization. So it comes about that sick people are often regarded as cases rather than persons, and many things in the history of their sickness, many others concerning their environment, which were familiar to general practitioners of an earlier day, are likely to be overlooked and not even suspected. And yet disregard of such factors or of others that seem unimportant in the light of oversimplified theory leads to disaster. The disregarded factors are perhaps as often as not among those which the old-fashioned general practitioner intuitively recognized and which can sometimes be discovered only through intimate acquaintance with the patient and familiarity with his environment, with his life day-by-day, and with his family history.

There are signs of a growing interest in such considerations and of a corresponding realization that successful medical practice must take account of the patient as a person. One reason for this is not obscure, for the practice of medicine is action under the burden of responsibility, of partial responsibility for the outcome of a sickness and complete responsibility for the results of treatment. In the long run responsibility for decision and action is likely to cure the errors of oversimplified thinking, for, as Bacon said, sciences are judged by their fruits, and in medical practice the outcome of treatment is no less a test of the doctor's use of his conceptual scheme, and in the end of that scheme itself, than is the outcome of a laboratory experiment a test of the theory of the experiment.

Theories that will not work must be modified or abandoned. If they are constantly tested and will not work, sooner or later this will happen. But untested theorizing may continue indefinitely.

The facts of pathology and bacteriology, the specific procedures that have been discovered in the treatment of infectious diseases, in nutritional disturbances and in conditions associated with disturbances in the balance of hormones have given rise to theories that seem to be too well established to be overthrown. And yet we shall do well to remember the development of modern physics. For the diagnosis, prognosis and treatment of many cases, at all events, such theories are sufficient. Since they are thus successful, it seems probable that when they fail it is owing to disregard of factors neglected in the theories. In like manner Boyle's law successfully describes the behavior of a gas when temperature remains constant, but fails when temperature varies widely.

In sum, by the process of trial and error, the practice of medicine slowly eliminates fallacies of misplaced concreteness. There is perhaps no sphere of activity in which this elimination is going on more continuously and more effectively, for here theory on a grand scale and a great accumulation of systematic descriptive knowledge are at the foundation of thinking, which is therefore explicit. The thinking, however, is nearly always modified by intuitive familiarity born of experience and by at least a vague sense of the dangers of elaborate deductive reasoning. Among the best physicians it is therefore cautious. But, above all, the doctor's thinking issues in decision, and decision in action. Thus the thinking is continuously put to the test of observation and experiment.

One thing is lacking that would greatly contribute to the efficacy of this elimination of the fallacy, namely, a thorough understanding of the logical nature of the fallacy and easy familiarity with the complexity of the usual mathematical interrelations among many interdependent factors. For the interdependence of many variables can only be treated mathematically. Accordingly, acquaintance with this interdependence and familiarity with it are neither more nor less than acquaintance with and familiarity with the properties of certain kinds of mathematical operations in certain kinds of mathematical systems. But it is almost never possible—one might say it is never possible —to formulate clinical reasoning in mathematical terms. Therefore the doctor, lacking a certain logical discipline through inexperience of mathematical practice, can not clearly conceive the intricacy of the problems that confront him, for here, as everywhere else, practice is necessary to understanding.

So much for the present state of scientific medicine, of which the merits and defects seem to be fairly plain —at least in those aspects which concern us here.

The social sciences are very different from the medical sciences. Their development has been different; their present state is different. The habits, the attitudes, the procedures of social scientists are, in general, very different from those of medical scientists. And to-day the applications of medical science are innumerable, while it is hard to find effective applications of social science. Let us consider the two groups of sciences comparatively.

Near the end of the "Nicomachean Ethics,"[5] Aristotle prepares the way for his transition to the study of politics with the following remarks:

> Must we not, then, next examine whence or how one can learn how to legislate? Is it, as in all other cases, from statesmen? Certainly it was thought to be a part of statesmanship. Or is a difference apparent between statesmanship and the other sciences and arts? In the others the same people are found offering to teach the arts and practising them, *e.g.*, doctors, or painters; but while the sophists profess to teach politics, it is practised not by any of them but by the politicians, who would seem to do so by dint of a certain skill and experience rather than of thought; . . . experience seems to contribute not a little; else they could not have become politicians by familiarity with politics; and so it seems that those who aim at knowing about the art of politics need experience as well.
>
> But those of the sophists who profess the art seem to be very far from teaching it. For, to put the matter generally, they do not even know what kind of thing it is nor what kinds of things it is about; . . . For while people experienced in any department judge rightly the works produced in it, and understand by what means or how they are achieved, and what harmonizes with what, the inexperienced must be content if they do not fail to see whether the work has been well or ill made. . . .

Elsewhere Aristotle says,[6] ". . . people who have spent their lives observing nature are best qualified to make hypotheses as to the principles that bring great numbers of facts together."

Aristotle's criticism may still be made, more than two thousand years after, of much of our current social science, and his explanation of the grounds for his criticism may still be given. In their work social scientists rarely combine theory and practice, and still more rarely work hard, persistently, intelligently, responsibly, unremittingly on the phenomena, in direct, intimate relations with the men and things they study. Accordingly, they commonly lack intimate, habitual, intuitive familiarity with the objects of their investigation.

[5] Book X, from "The Works of Aristotle," ed. by W. D. Ross, The Clarendon Press, Oxford, 1925, Vol. IX.

[6] "De generatione et corruptione," I, 2, 10.

In the social sciences special methods and special skills are few. It is hard to think of anything that corresponds to a mathematician's skill in performing mathematical operations or to a bacteriologist's skill in cultivating microorganisms or to a clinician's skill in making physical examinations. Even in conducting an interview, skill is to be sought among physicians, or certain lawyers, rather than among the generality of social scientists.

Classificatory descriptive knowledge, which is so conspicuous in the medical sciences and in natural history and which has proved so essential to the development of such sciences, is relatively lacking in the social sciences. The most serious effort in this direction with which I am acquainted is Pareto's taxonomic study of the residues, that is, of the manifestations of sentiments. Successful and important as this is, it is but the beginning of a vast and difficult undertaking. Moreover, there is no common accord among social scientists concerning the classes and subclasses of the things they study, and there is even much disagreement about nomenclature.

The theories of the social sciences seem to be in a curious state. One body of theory, that of economics, is highly developed, has been cast in mathematical form and has reached a stage that is thought to be in some respects definitive. This theory, like those of the natural sciences, is the result of the concerted efforts of a great number of investigators and has evolved in a manner altogether similar to the evolution of certain theories in the natural sciences. But it is hardly applicable to concrete reality. As Marshall has said:[7] "There is . . . no scope in economics for long chains of deductive reasoning; that is for chains in which each link is supported, wholly or mainly, by that which went before, and without obtaining further support and guidance from observation and the direct study of real life." Pareto goes quite as far in condemning the applications of economic theory.

The reasons why economic theory is so difficultly applicable to concrete events are that it is an abstraction from an immensely complex reality and that reasoning from theory to practice is here nearly always vitiated by the fallacy of misplaced concreteness. Such application suggests the analogy of applying Galileo's law of falling bodies to the motion of a falling leaf in a stiff breeze. Experience teaches that under such circumstances it is altogether unsafe to take more than a single step in deductive reasoning without verifying the conclusions by observation or experiment. Nevertheless, many economists, some cautiously and others less cautiously, are in the habit of expressing opinions deduced from theoretical considerations concerning economic practice. There is here a striking contrast with medicine, where it is almost unknown for a theorist inexperienced in practice to prescribe the treatment of a patient, and where it is well understood that apprenticeship in a hospital is the only effective preparation for practice.

In other fields of social science theories are generally not held in common by all investigators, but, like philosophical systems, tend to be sectarian beliefs. This is true even in psychology, where the conflicts of physiological psychologists, behaviorists, Gestaltists, psychoanalysts and others sometimes almost suggest theological controversy.

Further, it should be noted that social scientists often seek something else rather than convenience in the construction of their theories. Consider, for example, the following remarks of Durkheim:[8]

> A concept is an essentially impersonal representation; it is through it that human intelligences communicate.
>
> The nature of the concept, thus defined, bespeaks its origin. If it is common to all, it is the work of the community. Since it bears the mark of no particular mind, it is clear that it was elaborated by a unique intelligence, where all others meet each other, and after a fashion, come to nourish themselves. . . .
>
> The collective consciousness is the highest form of the psychic life, since it is the consciousness of the consciousnesses. Being placed outside of and above individual and local contingencies, it sees things only in their permanent and essential aspects, which it crystallizes into communicable ideas.

And now note that we are well acquainted with a great number of essentially impersonal representations, such as acceleration in dynamics, entropy in thermodynamics or natural selection in biology, that we well know to have originated with a particular person or persons. Whatever his motive, Durkheim is endeavoring to set up a hypothetical entity that can only cause inconvenience in work because, so far as we know, consciousness is a function of, or is associated with, individual nervous systems. Long ago the biologist Le Dantec said of the Ehrlich school of immunity that when they discovered a new phenomenon they invented a *phenominine* to explain it. And very much longer ago William of Occam stated the precept known as Occam's razor: "Entia non sunt multiplicanda praeter necessitatem," which is to say that our conceptual schemes should contain no more than the necessary elements.

On the whole, it seems fair to say that the social sciences in general are not cultivated by persons possessing intuitive familiarity, highly developed, sys-

[7] "Elements of Economics of Industry," Macmillan, London, 1905, p. 397.

[8] Selections adapted from "The Elementary Forms of Religious Life," pp. 432–37, in R. E. Park and E. W. Burgess, "Introduction to the Science of Sociology," University of Chicago Press, 1921, pp. 194–96.

tematic, descriptive knowledge, and the kind of theories that are to be found in the natural sciences.

There is not a little system-building in the social sciences but, with the striking exception of economic theory, it is of the philosophical type rather than of the scientific type, being chiefly concerned in its structural elements with words rather than with things or, in old-fashioned parlance, with *noumena* rather than with *phenomena*. This involves what I have already described as thinking, talking and writing about vague or general ideas or "concepts" which do not clearly relate to concrete observations and experiences.

For scientific purposes, or for clear thinking of any kind, experience shows that such things will not serve. In support of this assertion I venture to appeal to the late Justice Oliver Wendell Holmes, who once remarked:[9] "I have said to my brethren many times that I hate justice, which means that I know if a man begins to talk about that, for one reason or another he is shirking thinking in legal terms." I shall presume to make a single exegetical remark on Holmes's text: the phrase "shirking thinking in legal terms" may be generalized to read "shirking thinking in terms that can be used for even rough and ready logical purposes or for any sort of clear thinking."

I believe it not unfair to take as an illustration of what is here in question Reinach's definition of religion:[10] "An ensemble of scruples which impede the free exercise of our faculties." After stating this definition, Reinach at once goes on to remark: "This minimum definition is big with consequences, for it eliminates from the fundamental concept of religion, God, spiritual beings, the infinite, in a word, all we are accustomed to consider the true objects of religious sentiment." He has previously pointed out that definitions of religion are many and diverse and that they have not been found convenient in scientific work. The general confusion that has ensued from their use might well suggest the inference that to set up definitions of such a word, at all events without taking very unusual precautions, is inexpedient. Reinach's definition, like most definitions of religion, is a more or less precise designation of attributes of some religions; in other words, the statement of what the author believes or wishes to believe a satisfactory *differentia*. Reinach's remark about the consequences of his definition is almost comic. What are the possible consequences of adopting a definition? Assuredly, no definition can modify the phenomena or the relations between the phenomena. On the other hand, it can and ordinarily does modify the behavior of the person who accepts it, and Reinach naïvely admits as much by noting that certain things are eliminated from the fundamental *concept* of religion. Now, what he eliminates in the beginning will, unless he blunders, not be found in his final conclusion.

Why does Reinach speak of "scruples which impede," and not of needs which further "the free exercise of our faculties"? He is evidently referring to phenomena which arise, at least in part, from systems of conditioned reflexes, and his restriction in pejorative. We know that hostility to contemporary religions was common in Parisians of his class at the time when he wrote "Orpheus." It is therefore not unlikely that such hostility partly explains the defects, from the scientific point of view, of his definition.

A further difference between most system-building in the social sciences and systems of thought and classification of the natural sciences is to be seen in their evolution. In the natural sciences both theories and descriptive systems grow by adaptation to the increasing knowledge and experience of the scientists. In the social sciences systems often issue fully formed from the mind of one man. Then they may be much discussed if they attract attention, but progressive adaptive modification as a result of the concerted efforts of great numbers of men is rare. Such systems are in no proper sense *working* hypotheses, they are "rationalizations." Or at best they are mixtures of working hypotheses and "rationalizations."

Thinking in the social sciences suffers, I believe, chiefly from two defects: one is the fallacy of misplaced concreteness, the other the intrusion of sentiments—of Bacon's Idols—into the thinking, which may be fairly regarded as an occupational hazard of the social scientists. There can be little doubt that this intrusion is one of the factors that make the quotations just cited from Durkheim and Reinach unacceptable as science. Let us consider one more example.

Macaulay says:[11] "[The errors in the works of Machiavelli] arise, for the most part, from a single defect which appears to us to pervade his whole system. . . . The great principle, that societies and laws exist only for the purpose of increasing the sum of private happiness, is not recognized with sufficient clearness." What is the source of this great principle? Evidently it is not an induction from experience. What is the meaning of purpose as applied to the existence of societies? From a scientific point of view, purpose must be somebody's purpose. Like consciousness, it is associated with individual nervous systems. How can the sum of private happiness be measured? Assuredly not with any instruments or by

[9] "Justice Oliver Wendell Holmes: His Book Notices and Uncollected Letters and Papers." Edited by Harry C. Shriver, New York, 1936, p. 201.

[10] "Orpheus, A History of Religions," Horace Liveright, New York, 1930, Introduction, p. 2.

[11] Essay on "Machiavelli."

any procedures that were at the disposal of Macaulay. Is it not evident that Macaulay's "great principle" and his "purpose" of the existence of societies are both expressions of his sentiments, and that "the sum of private happiness" is, in the sense of the logic of modern science, a meaningless phrase? Finally, what is the probability that if Macaulay were writing his essay on Machiavelli in September, 1940, he would feel disposed to make similar assertions? The sentiments, like most other things, vary with time.

Sentiments have no place in clear thinking, but the manifestations of sentiments are among the most important things with which the social sciences are concerned. For example, the word "justice" is out of place in pleading before the Supreme Court of the United States, but the sentiments associated with that word and often expressed by it are probably quite as important as the laws of our country, not to mention the procedure of the Supreme Court. Indeed, such sentiments seem to be in many ways and at many times the most important of all social forces. The still dominant European intellectual tradition treats such things as if they had their origin in the logical thinking of those who manifest them. Yet the sentiments arise and manifest themselves in a manner that is hardly more appropriate for such treatment than is the manner in which the instincts and the passions manifest themselves.

The attribute "justice" is by men variously ascribed to various actions. This ascription varies with time, with place, with age, with sex, with social status, with purpose, with economic interests, with emotional excitement and with innumerable other factors. For the word "justice" is the expression of an attitude. In general, it is irrelevant to inquire whether an assertion which is the expression of an attitude is logically and objectively true or false.

Such attitudes and sentiments are closely related to conditioned reflexes and in part arise from the process of conditioning. This may be illustrated by considering the contrast between the meanings of such pairs of words as house and home, woman and mother, man and comrade, acquaintance and friend or enemy.

The acquired characters of men may be divided into two classes. One kind involves much use of reason, logic, the intellect; for example, the ordinary studies of school and university. The other kind involves little intellectual activity and arises chiefly from conditioning, from rituals and from routines; for example, skills, attitudes and acquired sentiments. In modified form, men share such acquired characters with dogs and other animals. When not misinterpreted, they have been almost completely neglected by intellectuals and are frequently overlooked by social scientists. In their study a great opportunity seems to present itself for the application of physiology.

The conclusions of this comparative study are as follows: First, a combination of intimate, habitual, intuitive familiarity with things; systematic knowledge of things; and an effective way of thinking about things is common among medical scientists, rare among social scientists. Secondly, systems in the medical sciences and systems in the social sciences are commonly different. The former resemble systems in the other natural sciences, the latter resemble philosophical systems. Thirdly, many of the terms employed currently in the social sciences are of a kind that is excluded, except by inadvertence, from the medical sciences. Fourthly, sentiments do not ordinarily intrude in the thinking of medical scientists; they do ordinarily intrude in the thinking of social scientists. Fifthly, the medical sciences have made some progress in the objective study of the manifestations of sentiments; the social sciences, where these things are particularly important, have neglected them. This is probably due to the influence of the intellectual tradition. Sixthly, in the medical sciences special methods and special skills are many; in the social sciences, few. Finally, in the medical sciences testing of thought by observation and experiment is continuous. Thus theories and generalizations of all kinds are constantly being corrected, modified and adapted to the phenomena, and fallacies of misplaced concreteness eliminated. In the social sciences there is little of this adaptation and correction through continuous observation and experiment.

These are very general conclusions to which, as I have already said, there are numerous and important exceptions. Perhaps the most important exceptions may be observed in the work of many historians, of purely descriptive writers, and of those theoretical economists who scrupulously abstain from the application of theory to practice.

When we reflect upon these differences between the two kinds of studies of men, shall we not do well to think also of the fruitfulness of the medical sciences and of the unfruitfulness of the social sciences? But let us not try to say what is here cause, what effect. Human interactions are intricate and obscure, and the art of studying them is difficult. That is, we can but feel, a part of the cause of the habits of thought and procedure of social scientists, and of the unfruitfulness of their science as well. Yet, assuredly, there is no simple cause of the present condition. What we can say with some confidence, for it is the lesson of experience, is this: The social sciences will become more fruitful when in certain ways the thought and procedures of social scientists conform more closely to those of medical scientists.

OBITUARY

CHARLES LLOYD CONNOR

CHARLES LLOYD CONNOR, M.D., professor of pathology at the University of California Medical School, died from a cerebral hemorrhage, on June 12, at the age of fifty years. After completing his medical education at Baylor University in 1920, Dr. Connor became a fellow of the National Research Council and later was appointed to the pathology staff at Harvard Medical School. In 1926, Dr. Connor acted as director of the pathology laboratory of the Montreal General Hospital. Following his return to Harvard, Dr. Connor was called in 1928 to be professor of pathology at the University of California Medical School, San Francisco. There he notably demonstrated his executive ability in organizing many effective cooperative research projects, in developing a capable staff, and in promoting an exceptional teaching and research museum. Dr. Connor's contributions to medical science include pioneer studies in Rocky Mountain Spotted Fever; the nature of normal and abnormal pigments in the body; malignant tumors, particularly those arising in bone, and more recently he has made fundamental studies regarding the pathogenesis of cirrhosis of the liver. His conclusion is now widely accepted that high fat intake with resulting prolonged fatty infiltration tends toward cirrhosis, especially in diabetes or in chemical injury, as in chronic alcoholism.

A memorial fund is being raised by his colleagues and students at the University of California Medical School as an expression of regard for his unselfish spirit and for generous efforts in the activities of the Medical School. C. L.

RECENT DEATHS

DR. WILLIAM HENRY BURNHAM, since 1936 professor emeritus of education and school hygiene at Clark University, with which he had been connected for thirty-five years, died on June 25 at the age of eighty-five years.

DR. VINNIE ARAH PEASE, since 1920 micro-analyst in the Bureau of Chemistry (now the Bureau of Agricultural Chemistry and Engineering), died on April 30 in her sixtieth year.

DR. LEE ELLIS MILES, for thirteen years plant pathologist for the Mississippi Experiment Station, died on May 11 at the age of fifty-one years.

DR. J. W. C. GUNN, professor of pharmacology and dean of the faculty of medicine of the University of Capetown, died on May 4 at the age of fifty-two years.

ALEXANDRE ARSÈNE GIRAULT died in the hospital in Brisbane on May 2. He was born at Annapolis, Md., U. S. A., in 1884, and was the author of numerous papers on Chalcidoidea. He was associated with the U. S. Bureau of Entomology and the University of Illinois. For many years he lived in Queensland, where he did entomological work for the Department of Agriculture and Stock.

SCIENTIFIC EVENTS

RETIREMENT OF HERBERT P. WHITLOCK OF THE AMERICAN MUSEUM OF NATURAL HISTORY

HERBERT P. WHITLOCK, who for the past twenty-five years has been curator of natural history of the Department of Minerals and Gems in the American Museum of Natural History, retired as head of the department on July 1, but he will continue to give his interest and support as curator emeritus and research associate in jade.

At a recent meeting of the executive committee of the board of trustees the following resolution was passed:

That the trustees learn with deep regret that Herbert P. Whitlock desires to resign as curator of the Department of Geology and Mineralogy, which he has served so loyally and so efficiently since his appointment on June 3, 1918. The museum is justly proud of its magnificent collection of gems and minerals which has been so greatly augmented by the untiring efforts and vigilance of Mr. Whitlock. In recognition of his faithful performance of his duties as curator and his unremitting interest in building up the museum's world-famous collections in his field, the trustees take pleasure in hereby appointing Mr. Whitlock *Curator Emeritus* of the Department of Geology and Mineralogy and *Research Associate in Jade*—these appointments to be effective as of July 1, 1941.

In making known the action of the Board of Trustees, Dr. Roy Chapman Andrews, director of the American Museum, said:

This will serve to notify his many friends that Mr. Whitlock's office will remain open to all those who seek his advice. Mr. Whitlock has long been known affectionately as "The Keeper of the Gems" in the museum, and there has never been a day that has passed but that from ten to twenty visitors beat a path to his office to ask the identification of some mineral specimen, the examination of a gem, or the story and symbolism of a piece of carved jade.

According to Mr. Whitlock's philosophy as to the work of a museum curator he has always demonstrated his belief that his time and efforts belong to the people of the

community and once remarked to me: "I believe that a modern well-equipped museum ranks among the greatest influences for culture, enlightenment and spiritual uplift in any community; because here, as with great music, writing and painting, men of vision may pass on their vision to their fellow men and to posterity. I believe that the language that a museum worker should be able to speak is the language of little children."

Mr. Whitlock has even taken the study of minerals and gems to the classrooms of New York City schools and colleges by means of special illustrated talks. His annual fall and spring series of lectures on jade and jade carving in the museum have made hundreds of enthusiasts for this beautiful gem stone. We are happy to announce that Mr. Whitlock will continue these talks in the future.

Under his leadership the collection of precious and semi-precious gems has increased from 2,060 to 2,562 exhibits, with many world-famous gems such as the magnificent De Long Star Ruby, the Schettler Emerald and the Morgenthau Topaz. The mineral collection has grown from 18,452 to 21,293, including many rare minerals discovered in recent years. Among the most recent additions is the mineral Whitlockite, a tricalcium phosphate discovered by Clifford Frondel and named in honor of Mr. Whitlock. All these specimens, selected with care after detailed scrutiny, have made the greatest single collection of minerals and gems on this side of the Atlantic. Outstanding among the exhibits is the magnificent Drummond Jade Collection, one of the most complete in the world, obtained through the efforts of Mr. Whitlock.

By action of the Board of Trustees, Dr. Frederick H. Pough, formerly assistant curator of geology and mineralogy, becomes, upon the retirement of Mr. Whitlock, acting curator of the Department of Minerals and Gems.

THE BOTANICAL EXPEDITION TO GUATEMALA OF THE FIELD MUSEUM

PAUL C. STANDLEY, curator of the herbarium of the Field Museum of Natural History, has returned to Chicago after an expedition of seven and a half months, during which he collected in almost all parts of Guatemala. He brought back approximately 30,000 specimens of plants for addition to the herbarium.

These plants and others collected on two previous expeditions conducted by Mr. Standley and Dr. Julian A. Steyermark, assistant curator of the herbarium, will be used in a research upon which will be based the preparation of the first complete flora of Guatemala to be published.

Mr. Standley reported that Guatemala is ably assisting in combating the problem of a possible shortage of supplies of the important drug quinine which might become unavailable from its present principal source, the Dutch East Indies, in the event of unfavorable developments in the international situation. He stated that quinine plantations, operated in Guatemala by United States capital, have been expanded rapidly and successfully, and will be able to produce a supply of the best grade of quinine adequate for a large part of American medicinal and industrial demands. In addition, Guatemala is operating the only commercial tea plantations outside the Orient.

Many species of plants hitherto unknown to science are included in the collections for the museum, and records were obtained of the growth of many plants known elsewhere but not previously found in Central America. The vegetation of the country is varied, ranging from plants of subarctic to tropical climate and from plants of the mountains to those of the plains. They include a wide variety of orchids.

THE HIGH SCHOOL OF SCIENCE IN NEW YORK CITY

THE first commencement of the High School of Science in New York City was held on June 26. Dr. Otis W. Caldwell, general secretary of the American Association for the Advancement of Science, and Dr. Thomas H. Briggs, of Teachers College, Columbia University, and others cooperated with Associate Superintendent Frederic Ernst in the establishment of the school last autumn, and Dr. Maurice Meister was appointed head master. Dr. Irving Langmuir, president of the American Association for the Advancement of Science, who was expected to make the principal address, was unable on account of illness to be present.

The school is housed in a building originally designed for an academic high school of a different type. In order to provide the special facilities needed for science study, the physical plant was revamped from cellar to roof. A WPA project costing more than half a million dollars is now nearing completion. Every feature of this project was planned by the faculty and arose out of the needs of the students and of the curriculum. The school now boasts of eight modern laboratories, ten preparation and store rooms, three fully equipped shops and twelve special science recitation rooms. In addition, there is a visual instruction lecture room, a large library, an English workshop, a voice recording studio, four mechanical drafting rooms, a graphic arts shop, a music room, a gymnasium and a swimming pool. The auditorium platform is equipped with a movable demonstration table which makes possible the presentation of science experiments to large audiences. The Board of Education has supplied the necessary, up-to-date equipment, books and materials. Next autumn, when the renovation project is completed, the High School of Science will enjoy the most unique physical plant in the country for the teaching of science to high-school boys.

THE OLIN HALL OF CHEMICAL ENGINEERING AT CORNELL UNIVERSITY

THE cornerstone of the Olin Hall of Chemical Engineering of Cornell University, to be erected at a cost of $700,000, was laid on June 14, during the annual alumni reunions. In the absence on account of ill health of Franklin W. Olin, the donor, the ceremony was performed by his son, John M. Olin, who made a brief address. Another son, Spencer T. Olin, was also in attendance.

President Edmund Ezra Day in his reply said:

> We have had a dream of the future of engineering at Cornell. It is a dream set in an illustrious record of achievement in the past in this field. It has to be remembered that it was at Cornell University that engineering was first recognized as worthy of support by the full resources of a great educational institution and first achieved distinction at the university level. It is unbelievable that engineering at Cornell should cease to have a place of great distinction in American education, but it has been clear at the same time that if that place were to be here, the existing resources of the Engineering College here at Ithaca had to be promptly and substantially amplified. Consequently, we have been dreaming dreams. For a time they seemed to be but dreams. Then Franklin W. Olin stepped into the picture and gave us reassurance of immeasurable value. Sometimes benefactions have values which defy measurement. It is my opinion that this great gift of Mr. Olin falls in that class. Not only does it supply the need of modernized facilities for the School of Chemical Engineering; it gives reassurance of the success of the whole Engineering College program. The value of this gift is enhanced because of its timing. It comes at a time when this undertaking needed just the kind of "lift" that this edifice gives. Nothing that has happened at Cornell since I have been here has afforded so much encouragement for the future.

Dean S. C. Hollister, of the College of Engineering, who presided at the ceremony, then introduced Spencer T. Olin, who briefly substantiated the sentiments expressed by his brother; Ezra Whitman, chairman of the Trustee Committee on Buildings and Grounds; Provost H. W. Peters; Maxwell M. Upson, chairman of the Committee on Development of the Endowed Colleges of the Board of Trustees; John Lowry, of John Lowry, Inc., contractor of the building; Harold Shreve, of Shreve, Lamb and Harmon, architects of the building, and Dr. F. H. Rhodes, Johnson professor of industrial chemistry and director of the School of Chemical Engineering. It is planned to open the new building in the autumn.

THE PUBLIC HEALTH RESEARCH INSTITUTE OF NEW YORK CITY

AN appropriation of $100,000 is included in the 1941–42 budget of the Health Department for the new Public Health Research Institute of New York City. It will be used exclusively for scientific research essential for the protection and the improvement of the health, safety and welfare of the people of the city.

Following favorable action by the Board of Estimate and the City Council, the Board of Estimate on June 26 authorized the city to enter into a contract with the Research Institute. This will be a scientific, non-profit organization, entirely devoted to obtaining for the city the best available biological products and advanced skill and procedures for combating disease and epidemics which occur or may occur.

In commenting on the Board of Estimate's approval of the contract, Mayor F. H. LaGuardia said:

> Many public health problems that arise in this city are peculiar to this locality, and scientific research and experimentation with regard thereto must be done locally. In this the largest city in the world, disease may readily assume epidemic proportions and thus it is most essential that our municipal Health Department be fortified with the best research talent and facilities available. The Research Institute will make that possible.

Dr. John L. Rice stated that David M. Heyman, a member of the banking firm of Adolph Lewisohn and Sons, had been named president of the institute and a member of the Board of Health. The *President* of the Board of Health is David Rockefeller, son of John D. Rockefeller, Jr.; the *Vice-president,* David Morse, attorney; the *Secretary* and *Treasurer,* Edwin P. Chinlund, president of the Postal Telegraph Company. *Ex-officio* members of the board are: Mayor LaGuardia, Comptroller Joseph D. McGoldrick and the Health Commissioner.

A research council has been set up by the board, with Dr. Thomas M. Rivers, director of the Hospital of the Rockefeller Institute for Medical Research, as *chairman.* Dr. Rivers also is a member of the Board of Health of New York City. Other medical and scientific men named to the Research Council are:

> Dr. Eugene L. Opie, professor of pathology, Cornell University Medical College; Dr. Henry Clapp Sherman, professor of chemistry, Columbia University; Dr. Michael Heidelberger, associate professor of biochemistry of the College of Physicians and Surgeons, Columbia; Dr. George Baehr, clinical professor of medicine of the College of Physicians and Surgeons, who is also physician to Mount Sinai Hospital, trustee of the New York Academy of Medicine and chairman of its Public Health Relations Committee, and Dr. Ralph S. Muckenfuss, director of the Bureau of Laboratories of the Department of Health, member *ex-officio.*

The contract between the city and the Research Institute, approved by the Board of Estimate, became effective on July 1. Neither members of the Board of Directors nor of the Research Council will receive

salaries, the province of the former being to assure sound business management and of the latter to retain the necessary scientific personnel. The institute will be housed in the William Hallock Park Laboratory in the Bureau of Laboratories of the Health Department.

MEETING OF THE INTERNATIONAL COLLEGE OF SURGEONS IN MEXICO CITY

ON the invitation of the Mexican Government the International College of Surgeons will hold its fourth international assembly in Mexico City from August 10 to 14.

Surgeons from most of the countries of the western hemisphere and also from England, Holland, Palestine, Portugal, Switzerland and Turkey will participate. Many of the Pan-American countries are sending official representatives. Sessions will be conducted in both English and Spanish.

More than one hundred and twenty speakers will describe the latest advances in surgery of their particular countries. Especially emphasized will be military surgery, and the lessons learned from the Spanish civil war, current British campaigns and civilian experiences during air raids. There will also be numerous exhibits of recent surgical research, operative clinics at many hospitals and demonstrations by leading manufacturers of newly developed equipment. Headquarters are at the Hotel Reforma.

Among the lecturers will be Dr. Francisco Castillo Najera, Mexican Ambassador to the United States; Dr. Fred H. Albee, New York, international president of the college; Dr. Manuel A. Manzanilla, Mexico City, president of the Mexican Committee of Organization; Dr. Desiderio Roman, Philadelphia, president of the United States Chapter, and Dr. Max Thorek, Chicago, international secretary.

The International College of Surgeons was founded at Geneva, Switzerland, in 1935, and has chapters in most of the nations of the world.

SCIENTIFIC NOTES AND NEWS

THE autumn meeting of the National Academy of Sciences will be held at the University of Wisconsin on October 13, 14 and 15. This is the first meeting of the academy to be held west of Chicago since 1925. The address of welcome will be made by Dr. Clarence A. Dykstra, president of the university, to which Dr. Frank B. Jewett, president of the academy, will respond.

THE Ward Burdick Gold Medal, presented annually by the American Society of Clinical Pathologists for an "outstanding contribution in the field of pathology," has been awarded to Dr. Harry P. Smith, of the University of Iowa, in recognition of his work on vitamin K as a blood-clotting agent.

THE Society for the Promotion of Engineering Education has awarded the Lamme Medal for 1941 to Dr. Anson Marston, dean emeritus and for fifty years a member of the faculty of the Iowa State College of Agriculture and Mechanical Arts at Ames. The award is the fourteenth made by the society for achievement in engineering education in memory of Benjamin G. Lamme, a pioneer in the engineering development of electric power.

THE Council of the London Mathematical Society has awarded the De Morgan Medal to Professor Louis Joel Mordell, of the University of Manchester.

AT the anniversary meeting of the Linnean Society of London, its Gold Medal was presented to Professor A. G. Tansley, emeritus professor of botany in the University of Oxford, in recognition of his contributions to ecology, and particularly to the development of the subject in Great Britain. The medal is awarded annually to "an eminent biologist as an expression of the society's estimate of his services to science." The Carnegie Corporation of the United States has recently granted to the society the sum of £2,000 for the purpose of photographing the manuscripts and natural history specimens in the collections of Linnaeus. The following have been elected officers of the society: *President,* Dr. E. S. Russell; *Treasurer,* Major F. C. Stern; *Secretaries,* I. H. Burkill (botany), and Dr. Malcolm Smith (zoology); *New Members of the Council,* Dr. B. Barnes, Professor F. T. Brooks, J. E. Dandy, A. C. Gardiner and Douglas M. Reid.

THE Council of the Royal Society of New South Wales has awarded the Clarke Memorial Medal to Professor F. Wood-Jones, now professor of anatomy at the University of Manchester, in recognition of his researches in zoology in Australia.

DR. CARL J. WIGGERS, professor of physiology of the School of Medicine of Western Reserve University, was awarded the honorary degree of doctor of science by the University of Michigan at its commencement exercises on June 21.

MICHIGAN STATE COLLEGE, at its eighty-third annual commencement on June 14, conferred the honorary degree of doctor of agriculture upon John A. Hannah, president-elect of the college, and on Howard E. Babcock, president of the Board of Trustees of Cornell University, and, as recorded in the last

issue of SCIENCE, the degree of doctor of science upon Truman G. Yuncker, professor of botany at DePauw University.

AT the fiftieth annual commencement exercises on May 30 of Buena Vista College, Storm Lake, Iowa, the honorary degree of doctor of science was conferred on Dr. Stanley B. Fracker, in charge of the Division of Plant Disease Control of the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture. Dr. Fracker gave the commencement address, which was entitled "Retreating Frontiers."

DR. ERNEST SACHS, professor of neurological surgery at Washington University, St. Louis, has been elected an honorary member of the Royal Society of Medicine.

HOMER J. HENNEY, chief of the program planning division of the Federal Crop Insurance Corporation of the U. S. Department of Agriculture, has been appointed dean of agriculture at Colorado College and director of the Experiment Station.

AT the New York Medical College, Dr. J. A. W. Hetrick, head of the department of otolaryngology and associate dean, has been appointed acting dean following the death of Dean Claude Adelbert Burrett. The separate departments of histology, embryology, neuroanatomy and gross anatomy have been merged in one department of anatomy under the chairmanship of Dr. C. E. Tharaldsen. The department will be known as the William Waldo Blackman Department of Anatomy. Dr. L. Corsan Reid has been transferred from the department of pathology to the department of physiology; Dr. Stephen P. Jewett has been appointed head of the newly established department of psychiatry, and Dr. Thomas I. Hoen, head of the department of neurology and neurosurgery. Dr. Joseph H. Fobes has become head of graduate surgery, and Dr. Louis René Kaufman, of undergraduate surgery. Dr. Reuel Allen Benson has been appointed Helen S. Case professor of pediatrics.

DR. J. N. GOODIER, head of the department of mechanics of the Sibley School of Mechanical Engineering of Cornell University, has been appointed head of the department of mechanics in the School of Civil Engineering. He will proceed with plans to correlate instruction in mechanics in the two schools of the College of Engineering.

DR. ARTHUR C. COPE, of Bryn Mawr College, has been appointed associate professor of chemistry at Columbia University.

THE announcement of the new appointment of Dr. Eugene F. DuBois at the Cornell University Medical College, in the last issue of SCIENCE, should have read "professor and head of the department of physiology and biophysics."

THE retirement from active service is announced of Dr. William H. Kenerson, professor of mechanical engineering, chairman of the division of engineering of Brown University, who has been a member of the faculty for forty-five years.

ACCORDING to *Nature*, Dr. W. G. Woolnough, geological adviser to the Federal Government of Australia, has retired from the Commonwealth Public Service after thirteen years service and has been succeeded by Dr. R. W. Raggatt, of the Commonwealth Geological Staff.

DR. THEODORE G. KLUMPP has resigned his position as chief of the Drug Division of the Food and Drug Administration to become director of the division of drugs, foods and physical therapy, and secretary of the Council on Pharmacy and Chemistry of the American Medical Association. He succeeds the late Dr. Paul N. Leech.

DR. FRANK T. MCFARLAND, head of the department of botany at the University of Kentucky, has been named first curator of the university herbarium. There are approximately 30,000 plants already in the collection, and about 10,000 still unidentified.

DR. JOHN FRAZER, secretary of the committee on science and arts of the Franklin Institute, Philadelphia, has been elected assistant secretary of the institute.

DR. H. I. CRAMER, professor of rubber chemistry at the University of Akron, Ohio, has resigned to become associated with the Research and Development Department of Sharpless Chemicals, Inc., Philadelphia.

THE William Lowell Putnam Scholarship for 1941 for study at Harvard University has been awarded to Richard F. Arens, of the University of California at Los Angeles.

THE Charles W. Hargitt research fellowship in zoology at Duke University has been awarded for the year 1941–42 to Dr. Dwight L. Ryerson, of the University of California at Los Angeles. Appointment to the fellowship is made annually for post-doctoral research in the field of cytology.

DR. LUDVIG GUSTAV BROWMAN, assistant professor of zoology and physiology at Montana State University, has received a second grant in aid of $500 from the National Research Council for the continuation of his research on the effect of light on the growth and activity of rats.

ACCORDING to *Museum News* Dr. F. Trubee Davison, president of the American Museum of Natural His-

tory, has been called to active duty in the Army Air Corps.

ACCORDING to the *News Edition* of the American Chemical Society Dr. Cecil G. Dunn, assistant professor of industrial biology in the department of biology and public health of the Massachusetts Institute of Technology, has been ordered to active duty by the War Department. He has been assigned to head the Section on Research and Development, Subsistence Branch, Supply Division, Office of the Quartermaster General, Washington, D. C.

THE American Society for X-Ray and Electron Diffraction, plans for which were announced in SCIENCE for May 23, starts its existence with a charter membership of 124. The officers elected for 1941 are: *President,* M. L. Huggins, of the Eastman Kodak Company; *Vice-president,* B. E. Warren, of the Massachusetts Institute of Technology; *Secretary-Treasurer,* George Tunell, of the Geophysical Laboratory, Washington, D. C. The first meeting of the society will be held from July 28 to August 1 at Gibson Island, Md., in cooperation with Section C of the American Association for the Advancement of Science. Reservations for this meeting are in charge of Dr. Neil E. Gordon, Gibson Island, Md.

To meet increasing demands for trained meteorologists, the University of Cincinnati has announced a new four-year undergraduate program in meteorology leading to the B.A. degree, which is believed to be among the first of its kind in the United States. Students will be trained for positions with air lines, at airports and air bases, and with weather bureaus. Both the Army and Navy are reported to be facing a shortage of specialists in meteorology, particularly in their air services.

THE Harvard College Observatory will issue this summer a new series of nine popular books covering the principal areas of astronomy, edited by Professor Harlow Shapley and Associate Professor Bart J. Bok. The books will be titled "The Harvard Books on Astronomy," and are written by the Harvard Observatory specialists in the various fields. Five of the volumes are now in press, and the remaining four will be issued before fall. The volumes will give a complete and simplified presentation of modern scientific knowledge in each of the major fields of astronomy, it was explained. They are designed for adults and secondary school or university students, having acquaintance with the elementary principles of physics. By separating the treatment into nine volumes, of about two hundred pages each, it will be possible to keep the series up to date by issuing new editions of individual volumes.

A COMPLETE replica of the Westinghouse Time Capsule and its contents has been installed as a permanent exhibit at the Hayden Planetarium of the American Museum of Natural History. It was opened to the public at dedication ceremonies on June 17. This 800-pound specially constructed capsule was presented by David S. Youngholm, vice-president of the Westinghouse Electric and Manufacturing Company, and was accepted for the Hayden Planetarium by Professor William H. Barton, Jr., executive curator of that institution.

IT is stated in the London *Times* that the herbarium near Hudiksvall, in Sweden, containing 30,000 specimens of preserved roses, compiled and classified by the late Reinhold Matsson, the Swedish churchman and botanist, has been destroyed by fire.

Nature writes: "War has again inflicted severe losses on the University of Louvain. Numerous university buildings were destroyed during hostilities, including the library rebuilt by American generosity and restocked by gifts from nearly every university in the world. Of its 900,000 volumes 15,000 only remain intact, and of its 800 manuscripts only 15 are left."

ACCORDING to *The Australian Journal of Science* the Minister of Labor and Industry, Mr. Holt, has arranged that a scientific mission be sent from Australia to Canada, the United States and Great Britain, in order to coordinate technical work in relation to the war, particularly in the fields of physics and engineering.

DISCUSSION

ESTABLISHMENT OF A NATURAL AREA ON THE HUNTINGTON WILDLIFE FOREST

ON January 18, 1941, the New York State College of Forestry, through the Executive Committee of the Board of Trustees and upon recommendation of Dean Samuel N. Spring, established a Natural Area of approximately 1,000 acres on the Huntington Wildlife Forest. The Forest, a 15,000 acre tract in the central Adirondacks west of Newcomb, N. Y., is held in trust for the New York State College of Forestry for "investigation, experiment and research in relation to the habits, life histories, [and] methods of propagation and management of fish, birds, . . . and . . . mammals . . ." and is administered by the Roosevelt Wildlife Forest Experiment Station under the direction of R. T. King. The Natural Area, a typical sample of the spruce- northern hardwoods vegetation in the Adirondack region (lower Canadian Zone of Merriam), is a

triangular tract which lies in the northwest part of the Forest, bounded on the southeast by the three-mile long Catlin Lake. It is covered largely by old growth, but not virgin, spruce- northern hardwoods, together with upper spruce slopes, spruce flats and typical lake-shore and lowland vegetation. Several clearings remain from an original settlement.

Appreciation for the role of the Natural Area in land management research is developing rapidly. New possibilities are revealed where multiple land use is designed to supply the highest returns of such renewable resources as timber, wildlife, forage, water and recreational values. New interpretations of the critical controls of vegetation are made possible, not only in terms of the constantly acting and greatly over-emphasized weather and soil, but also of the intermittently acting factors such as fires, hurricanes and epidemic and cyclic population variations. New methods of management are revealed for regions remote or of irregular terrain where the vegetation must be controlled indirectly for conversion to desirable semi-natural types. For such reasons as these, it is of the utmost importance that samples of natural vegetation be preserved or be permitted to develop for study and reference. Increased though still insufficient interest in this subject has been evoked by such statements as those of Shelford,[1] Leopold,[2] Ashe,[3] Pearson,[4] Adams,[5] Shelford,[6] Toumey and Korstian,[7] Hanson,[8] Piemeisel,[9] Baldwin,[10] and Hough.[11] Due to the work of these men and others, natural areas have been established in many parts of the country, the most outstanding recent ones being the Panama Canal Zone Biological Area in Gatun Lake and the Tionesta Natural Area of 2,100 acres in northwestern Pennsylvania.

Regretfully, because the foresight of our forefathers was not always as well developed as we consider our own to be, many extensive parts of the northeast have been entirely stripped of their original vegetation cover, leaving nothing to indicate what the land had borne and might bear under a dynamic natural equilibrium. Although this is not entirely true of the Adirondacks, where state-owned virgin timber still exists at the higher elevations, protected by the provisions of the New York State Forest Preserve, no tract has come to the attention of the author which is at elevations comparable to those of the Huntington Forest and satisfactorily located in reference to other experimental lands as to permit a broadly planned research program. For the fulfilment of such a role, the Huntington Forest Natural Area is dedicated to scientific research of natural equilibria and is to be administered with full recognition of the dangers inherent in unwarranted trespass. It is to serve as an outdoor laboratory for studies of wildlife, flora, forests, soil and influences, and is admirably suited for long-time studies of conditions uninfluenced by anthropic factors. It is designed for investigations of the changes concomitant with the attainment of a dynamic equilibrium of flora, soils and weather, as well as fluctuations and variations in response to biologic and climatic cycles and to natural regeneration. Its position in the Huntington Wildlife Forest will permit it to benefit by the proximity of the technical headquarters of a field experiment station and to serve as an integral check area for purposes of comparison both with other and parallel experiments being run under disturbed conditions and with cultural operations throughout this part of the Adirondack Mountains.

FRANK E. EGLER

THE NEW YORK STATE COLLEGE
OF FORESTRY,
SYRACUSE UNIVERSITY

[1] F. B. Sumner, SCIENCE, 54 (1385): 39–43, 1921.
[2] A. Leopold, *Jour. For.*, 19: 718–721, 1921.
[3] W. W. Ashe, *Jour. For.*, 20: 276–283, 1922.
[4] G. A. Pearson, *Ecol.*, 3: 284–287, 1922.
[5] C. C. Adams, N. Y. S. Mus. Bull. 279: 37–46, 1929.
[6] V. E. Shelford, *Ecol.*, 14: 240–245, 1933.
[7] J. W. Toumey and C. F. Korstian, Foundations of Silviculture, p. 3, 1937.
[8] H. C. Hanson, *Sci. Mon.*, 48: 130–146, 1939.
[9] R. L. Piemeisel, SCIENCE, 92(2383): 195–197, 1940.
[10] H. I. Baldwin, SCIENCE, 93(2404): 81–82, 1941.
[11] A. F. Hough, *Ecol.*, 22: 85–86, 1941.

THE RELATION BETWEEN MENTAL AND PHYSICAL DEVELOPMENT

IN a recent publication[1] Professor Franz Boas discussed the results of a growth study done in the Lincoln School. Emphasis was placed on the unexpectedly high relation between intelligence quotients and indices of physical development, both expressed as deviations from the mean of the age group. The graphs in which stature deviations were plotted against intelligence quotient deviations appear to be based on 22 points for the boys and 17 points for the girls. Assuming that these points represent individuals it is possible to compute coefficients of correlation. These are $+.68 \pm .08$ for the boys and $+.47 \pm .10$ for the girls. If, however, these points represent averages, the correlations can not be estimated from inspection of the graphs. Measures of variability must also be available.

Professor Boas feels that these results corroborate the inference drawn by him from the work of Porter.[2] Now, Porter's data show only the means without corresponding measures of variability. From the means alone one would conclude that, at a given age, physically accelerated children are in advanced grade loca-

[1] F. Boas, SCIENCE, n.s., 93: 339, 1940.
[2] W. T. Porter, *Trans. of the Academy of Science of St. Louis*, 6: 161, 1895.

tions. And, conversely, physically retarded children are retarded in grade location. But Porter does present, by way of illustration, the complete data on weight and grade location for 2,169 boys at age 9. A coefficient of correlation based on this portion of his total group is $+.06 \pm .01$.[3] Other studies are, in general, comparable. Correlations between height or weight with measures of intelligence appear regularly in the range $+.10$ to $+.20$. Baldwin[4] found a partial correlation, age constant, between height and mental age of $+.53$. But the partial between weight and mental age was $-.15$ on the same group, although height and weight are in general correlated closely.

The same problem has been attacked through longitudinal studies[5] in which spurts in physical growth are correlated with spurts in mental growth. Whether mental growth is measured by intelligence tests or school achievement seems not to be important. The correlations are in the area $+.15$.

The results cited by Professor Boas are, therefore, not in agreement with previous findings. In view of the lively controversial aspects of this problem the complete presentation of the data referred to by Professor Boas will be awaited with interest.

WILLIAM S. CARLSON
UNIVERSITY OF MINNESOTA

THE SOLAR RADIATION CONSTANT AND THE ACTIVE REGION ON THE SUN

IN the April 11, 1941, number of SCIENCE Dr. C. G. Abbot, secretary of the Smithsonian Institution, has published a paper on some variations in the solar radiation constant which have not hitherto been described. Some of these variations in the intensity of solar radiations have occurred at successive periods of the solar rotation, indicating that they are, at least temporarily, confined to some geographic region upon the sun.

In a paper entitled "On the Localization of Sun-spots and Floccular Activity on the Sun's Surface" in *Publications of the Astronomical Society of the Pacific,* Vol. 47, 1935, and in SCIENCE of October 4, 1940, there was published a paper entitled "The Active Region on the Sun's Surface," in both of which papers attention was called to a permanently active sun-spot region occurring at definite intervals of 27.25 days. This region was shown to have been facing the earth on May 2, 1931, which was the last maximum referred to in the 1935 paper in the *Publications of the Astronomical Society of the Pacific.*

From the several dates to which Dr. Abbot refers as showing radiation irregularities, a few have been selected for comparison with the time at which the maximum-sun-spot region must have crossed the sun's central meridian.

The dates August 18, 19 and 20, 21, 1929, are given. From August 20, 1929, to May 2, 1931, was 620 days, which equal 22 solar rotations of 27.25 days each, lacking seven days of 23 solar rotations.

Another selected date is December 4, 5 and 6, 7, 1929. From December 5, 1929, to May 2, 1931, is 512 days, which equals 18 solar rotations plus 21 days, or 6 or 7 days before the next maximum sun-spot region is facing the earth.

July 7, 8 and 9, 10, 1930, are also referred to. From July 8, 1930, to May 2, 1931, is 298 days, or 10 solar rotations plus 25 days, or two days before the maximum of the next sun-spot region crosses the sun's principal meridian.

January 19, 1931, was 103 days before the disturbed region on the solar surface faced the earth. This was four solar rotations less six days.

The present writer undertook to find a relation between the solar constant and the permanently disturbed region on the sun several years ago, but without success. The limits of this region seem to be very sharply defined. However Abbot's results seem to suggest that the intensity of solar radiation may be related to the solar rotation period, but that its variation occurs a few days before the sun-spot disturbance region is facing the earth.

FERNANDO SANFORD
PALO ALTO, CALIFORNIA

AN ANALYSIS OF THE SPREAD OF EPIDEMICS

IN "Elementi per una teoria matematica del contagio" (Roma 1939, Editoriale aeronautico) Dr. Marcello Puma has developed an "equazione fondamentale," $\frac{\partial x}{\partial t} = k \,.\, x \,.\, (n - x)$, governing the spread of contagion.

I should like to state that in 1938 I published a paper ("Bibliotek for Laeger," November, 1938, Copenhagen), in which the above formula is developed and discussed as giving a possible explanation of epidemic waves. The paper contains some tests of the formula, comparing the courses of actual epidemics with the course described by the formula.

A much enlarged investigation of the theory supported by the analysis of numerous epidemics of different diseases will appear (in English) in "Acta medica scandinavica," Copenhagen.

HELGE PETERSEN
THE DANISH METEOROLOGICAL INSTITUTE,
COPENHAGEN

[3] D. G. Paterson, "Physique and Intellect," New York: Appleton-Century, 1930.
[4] B. T. Baldwin and L. I. Stecher, *Univ. of Iowa Studies in Child Welfare,* 2: 56, 1922.
[5] N. Bayley, 39th Yearbook, National Society for the Study of Education, Pt. 2: 49, 1940.

SCIENTIFIC BOOKS

NATIONAL UNITY AND DISUNITY

National Unity and Disunity. By GEORGE KINGSLEY ZIPF. xix + 408 pp. Bloomington, Ind. The Principia Press.

THIS is an interesting book. In it Dr. Zipf reports his discovery that in the United States and certain other nations at certain periods the population sizes of cities and towns form approximately a harmonic series, so that the rank of the city times its population size is a constant. This discovery may rank with Quetelet's discovery that the statures of men are distributed in accordance with the so-called normal probability curve. Dr. Zipf is greatly to be congratulated upon his perspicacity in making it.

He shows how the specialization of wealth and labor and the prevalence of exchange must produce an organization of the population into communities with some inverse relation between population-size and the number of communities, though this inverse relation could have many forms other than that of the harmonic series. Nobody, I judge, will dispute this. He argues that the distribution of communities to form a harmonic series must be related to and significant of something in the organization of a nation's life and work. Nobody should dispute this, though there will be many opinions about just what it signifies. He then argues that such a distribution to form a harmonic series signifies an "equilibrium" in a nation's affairs, and that such an equilibrium will tend to restore itself if it is disturbed by any force. "We shall find that any disturbance to the equilibrium of any social-economic system tends automatically to set forces in operation within that system to repel the source or to neutralize the effect of the disturbance in order to restore equilibrium" (p. 145). Though this doctrine will appeal to many sociologists, and to some biologists, it seems to the reviewer to be unwise, especially the second half of it. The valuable factual material relating the distribution of community sizes in various nations at various periods can, I think, be studied better without assuming any potency whatever in an "equilibrium" as such.

Dr. Zipf is led by his reflections on the harmonic series as a product of the social-economic organization of a nation to many comments of a more or less speculative nature on divers topics in history, sociology and government. I quote a few of them chosen almost at random:

"A nation may very well be a natural bio-social entity, quite comparable, in fact, to that of a colony of ants, or of bees, or of termites" (p. v).

"American paranoid tendencies may be felt to have reached their highest point in the last World War when the whole country, under an attack of mass-hysteria, crusaded 'to make the world safe for democracy' with all the delusions of grandeur, utopia, persecution and self-righteousness that are the stereotyped symptoms of this most vicious of mental diseases" (p. 79).

"As for the hope for a single world-wide all-inclusive homogeneous superstate with a single capital, the author finds no historical nor dynamic justification for it" (p. 182).

"Boundaries can be drawn" [in treaties or other agreements between nations] "in such a way that those living within the remaining boundaries and desirous of surviving can in fact survive only by reversing either (1) the physical laws of nature, or (2) the biological laws of nature, or (3) the psychological laws of nature" (p. 205).

"The author suspects that the cyclical business disturbances ('business cycles') of the past and present may conceivably be attributed in part to the alternation between an 'elite' and the 'entire nation' as the 'right number' for which the goods of society are produced" (p. 318).

"Indeed the turmoil of war and strife are perhaps to be viewed primarily as the correctives and 'cures' of maladjustments, rather than as their causes" (p. 404).

Opinions of experts in history, economics, government, psychology and sociology will vary widely concerning most of the dicta of which these are samples.

E. L. THORNDIKE

TEMPERATURE

Temperature. Its Measurement and Control in Science and Industry. American Institute of Physics. xiii + 1362 pp. New York: Reinhold Publishing Corporation. $11.00. 1941.

IN 1919 the American Institute of Mining and Metallurgical Engineers sponsored a Symposium on Pyrometry under the chairmanship of the late George K. Burgess. The resulting volume of papers, now long out of print, became one of the standard source books on temperature measurement. The book under review is likewise the published record of a symposium, but of considerably greater scope than the 1919 undertaking. Instead of being confined to temperatures above 500° C, it covers the whole range from absolute zero to stellar temperatures, and from highly "theoretical," *i.e.*, logical, considerations on thermodynamics through to the most practical instructions on how to control a furnace temperature when one is compelled to.

As might have been expected, the resulting 126 papers by 160 authors differ greatly in length, in interest and particularly in pertinence. The contributions by the high- and low-temperature physicists stick closest to the theme of the book; they are the least readable, and will be found ultimately the most useful. The contributions by the biological group are the most

interesting, and tell the least about temperature measurement. The temptation to write at length about the results rather than the methods of some very ingenious thermometry was too much for the physiologists and some of the engineers, but they do lend a variety that the old Pyrometry Volume lacked. The amount of information released by the metallurgical industries is disappointing, for reasons easily understandable in a year when commercial and national rivalries were rapidly becoming intensified. The section on thermometric metals and alloys, however, is timely and informative. In the engineering group the contributions from the petroleum industry are the best. The wide range of the subjects may be indicated by citing papers on the thermometry of lamp filaments, volcanoes and liquid helium.

A particularly valuable part of the book is the section of 32 pages devoted to tables, containing the most authoritative data now available to the thermometrist and including some that have not previously been published in current technical literature. This section of the book, bound in covers, is separately purchasable for $1.00.

Although the National Research Council made a grant of funds and twelve of the leading technical societies took an active part, both officially and through individual members, in organizing the symposium, the most effective help came from the thermometrists of the National Bureau of Standards, as is fitting for a volume intended to be an expanded sequel to Dr. Burgess's classic text and his earlier symposium.

The reviewer considers this volume indispensable for any technical or scientific library worthy of the name.

ROBERT B. SOSMAN
UNITED STATES STEEL CORPORATION,
KEARNY, N. J.

THE UNIVERSITY OF CHICAGO'S FIFTIETH ANNIVERSARY SYMPOSIA

A CORDIAL invitation is extended to scholars and scientists to attend a series of symposia and lectures in connection with the celebration of the fiftieth anniversary of the University of Chicago.

Nearly all the symposia and lectures will be held during the five days, September 22–26, inclusive. The American Association for the Advancement of Science will meet at the University of Chicago during this period, and the program in the sciences will be under the joint auspices of the university and the association. It should be noted, however, that the symposia on Astronomical Spectra (Yerkes Observatory, Williams Bay, Wisconsin, September 10–13), Respiratory Enzymes and the Biological Action of the Vitamins (September 15–17) and the Training of Biologists (September 18–20) will be held in advance of the meetings of the association.

More than one hundred visiting scientists and scholars, in addition to approximately fifty members of the university's faculties, will participate in the program, the general theme of which will be "New Frontiers in Education and Research."

In view of the limited capacity of the university's lecture halls, it is important that every one who desires to attend the symposia and lectures communicate as soon as possible with the Director of the Fiftieth Anniversary Celebration, the University of Chicago, and indicate the particular sessions in which he is interested. A copy of the announcement containing detailed information of the program and of housing accommodations for visitors will be sent on request.

The program of the symposia, in condensed form, is as follows:

September 13–15. Astronomical Spectra. At Yerkes Observatory. Participants: R. Wildt, R. C. Williams, W. W. Morgan, J. P. Kuiper, P. W. Merrill, T. Dunham, Jr., H. N. Russell, D. H. Menzel, M. Schwarzchild, P. Swings, A. B. Wyse, Otto Struve.

September 15–17. Respiratory Enzymes and the Biological Action of the Vitamins. Organized jointly by the University of Wisconsin and the University of Chicago, with sessions at Madison September 11–13. The program at Chicago will be devoted largely to the vitamins, and is supported by a grant from Abbott Laboratories. For the program of this symposium, address T. R. Hogness, University of Chicago.

September 18–20. The Training of Biologists. Under the chairmanship of P. A. Weiss. Fifteen members of the faculty of the University of Chicago and ten scientists from other institutions will participate in round-table discussions.

September 22. Growth and Differentiation in Plants. Charles E. Allen, University of Wisconsin; Edmund W. Sinnott, Yale University; John W. Mitchell, U. S. Department of Agriculture; John M. Beal, University of Chicago. Ezra J. Kraus, *chairman.*

Approaches to Linguistics. Edgar H. Sturtevant, Yale University; Amado Alonso, University of Buenos Aires; Clarence H. Faust and Charles W. Morris, University of Chicago. Clarence E. Parmenter, *chairman.*

The Editing of a Text. Edwin C. Armstrong, Princeton University; Gustave O. Arlt, University of California at Los Angeles; Rae Blanchard, Goucher College; William Roach, University of Pennsylvania; and Charles H. Beeson and James R. Hulbert, University of Chicago. William A. Nitze, *chairman.*

Organic Chemistry. William A. Noyes, Jr., University of Rochester; Louis P. Hammett, Columbia University;

Linus C. Pauling, California Institute of Technology; James Franck, Frank H. Westheimer and George W. Wheland, University of Chicago.

Environment and Education. Ernest Alexander, Institute of Psychoanalysis; Margaret Mead, American Museum of Natural History; Ernest W. Burgess and W. Lloyd Warner, University of Chicago. Robert J. Havighurst, *chairman.*

The Public Social Services: Fifty Years of Progress. Martha Eliot, Children's Bureau, U. S. Department of Labor; Florence Allen, judge of the U. S. Circuit Court of Appeals, Cincinnati, Ohio; Carter Goodrich, Columbia University; and Helen R. Wright, University of Chicago. Edith Abbott, *chairman.*

September 23. Life at High Altitudes and Aviation Medicine. Carlos Monge, University of San Marcos (Lima, Peru); David B. Dill, U. S. Army Air Corps; E. S. Guzman Barron, University of Chicago. Anton J. Carlson, *chairman.*

Levels of Integration in Biological and Social Systems. Libbie H. Hyman, American Museum of Natural History; James W. Buchanan, Northwestern University; Herbert S. Jennings, the Johns Hopkins University and the University of California at Los Angeles; Ralph W. Gerard, William Burrows, Thomas Park and Warder C. Allee, University of Chicago. William H. Taliaferro, *chairman.*

Interpretation and Criticism of Art and Literature. Charles R. Morey, Princeton University; Lily Bess Campbell, University of California at Los Angeles; Van Meter Ames, University of Cincinnati; Bernard Weinberg, Washington University; Elder Olson, Illinois Institute of Technology; Henri Frankfort, G. Haydn Huntley, Robert Vigneron and Norman F. MacLean, University of Chicago. Ronald S. Crane and Ulrich A. Middledorf, *chairmen.*

Organic Chemistry. Lawrence O. Brockway, University of Michigan; Francis O. Rice, Catholic University of America; Morris S. Kharasch, University of Chicago.

Surface Chemistry. Fritz London, Duke University; John G. Kirkwood, Cornell University; Henry Eyring, Princeton University; William D. Harkins, University of Chicago.

The Changing Bases of National Economy. John M. Clark, Columbia University; Frank H. Knight and Theodore O. Yntema, University of Chicago. Paul H. Douglas, *chairman.*

Management's Adjustment to the Changing National Economy. Willard L. Thorp, Dun and Bradstreet; Lewis C. Sorrell, Raleigh W. Stone and James W. Young, University of Chicago. William N. Mitchell, *chairman.*

The Conceptual Structure of Educational Research. Thomas R. McConnell, University of Minnesota; Douglas E. Scates, Duke University; Frank N. Freeman, University of California. Guy T. Buswell, *chairman.*

September 24. Visual Mechanisms. Selig Hecht, Columbia University; Ernst Gellhorn, University of Illinois; Samuel H. Bartley, Washington University; Karl S. Lashley, Harvard University; Arlington C. Krause, Heinrich Kluver, Theodore J. Case and Stephen Polyak, University of Chicago.

Levels of Integration in Biological and Social Systems. Clarence R. Carpenter, Pennsylvania State College and the School of Tropical Medicine (Puerto Rico); Alfred L. Kroeber, University of California; Alfred E. Emerson and Robert E. Park, University of Chicago. Robert Redfield, *chairman.*

Philosophic Procedures in the Arts and Sciences. Robebtr L. Calhoun, Yale University; Clarence I. Lewis, Harvard University; George Gentry, University of Texas; Friedrich Kessler, Frank H. Knight, and Charles Hartshorne, University of Chicago. Richard P. McKeen, *chairman.*

Surface Chemistry. Eugene Guth, University of Notre Dame; Henry B. Hull, Northwestern University; George H. A. Clowes, Eli Lilly and Company; Eli F. Burton, University of Toronto; Irving Langmuir and Vincent J. Schaefer, General Electric Laboratories; Ernst A. Hauser and A. J. Grossman, Massachusetts Institute of Technology; George E. Boyd, University of Chicago.

Measurement and Experiment. Samuel S. Wilks, Princeton University; Louis L. Thurstone, University of Chicago. William F. Ogburn, *chairman.*

Civilizations in Transition. Michael I. Rostovtzeff, Yale University; Hu Shih, ambassador of China to the United States; Robert H. Lowie, University of California. Louis Gottschalk, *chairman.*

September 25. Thoracic Diseases. Evarts A. Graham, Washington University; John Alexander, University of Michigan; Clayton G. Loosli, William E. Adams, Robert G. Bloch and Oswald H. Robertson, University of Chicago. Dallas B. Phemister, *chairman.*

Problems in Historical Materials. William L. Westermann, Columbia University; Alfred P. Dorjahn, Northwestern University; Ray Frantz, University of Nebraska; Leon C. MacKinney, University of North Carolina; S. R. Tompkins, University of Oklahoma; Richard P. McKeon and Bernadotte E. Schmitt, University of Chicago. Wilbur K. Jordan, *chairman.*

Frontiers of Knowledge in the Geologic Sciences. Ralph E. Grim and Gilbert H. Cady, Illinois Geological Survey; Reginald A. Daly, Harvard University.

The Place of Law in Society. Charles H. McIlwain, Harvard University; Hans Kelsen, formerly Geneva (Switzerland) Graduate Institute of International Studies and Prague (Czecho-Slovakia) German University; Robert H. Lowie, University of California. Charles E. Merriam, *chairman.*

September 26. Sex Hormones. Edward A. Doisy, St. Louis University; John S. L. Browne, McGill University; Carl R. Moore, Allan T. Kenyon and Fred C. Koch, University of Chicago. Frank R. Lillie, *chairman.*

Immunological Mechanisms. Linus Pauling, California Institute of Technology; Thomas M. Rivers, hospital of the Rockefeller Institute; William Bloom, Paul R. Cannon, and William H. Taliaferro, University of Chicago. George F. Dick, *chairman.*

Archeology as a Tool in Humanistic and Social Studies. Robert L. Engberg, American School for Oriental Research at Jerusalem; Michael I. Rostovtzeff, Yale University; William L. Westermann, Columbia University; Harold R. Willoughby, Neilson C. Debevoise, and Richard A. Parker, University of Chicago. Albert T. Olmstead, *chairman.*

Administrative Agencies: Recommendations of the Attorney-General's Committee. John F. Dulles, of the New York Bar; Walter Gellhorn, Columbia University; John Dickinson, University of Pennsylvania. Wilbert G. Katz, *chairman.*

Frontiers of Knowledge in the Geologic Sciences. Richard F. Flint, Yale University; A. I. Levorsen, American Association of Petroleum Geologists.

Cosmic Rays. Robert A. Millikan, California Institute of Technology; Bruno Rossi, Cornell University; William P. Jesse, Marcel Schein, Subrahmanyan Chandrasekhar and Ernest O. Wollan, University of Chicago.

The Place of Ethics in Social Science. Richard H. Tawney, University of London (tentative); Charles H. McIlwain, Harvard University; Jacques Maritain, Catholic Institute of Paris, Columbia University; Robert M. Hutchins, University of Chicago. John U. Nef, *chairman.*

In addition to the symposia, there will be the following lectures:

September 22. The Social Implications of Vitamins. Robert R. Williams, Bell Telephone Laboratories.

September 23. The Physiology of the Amino Acids. Donald D. Van Slyke, Rockefeller Institute for Medical Research.

September 24. Spinors and Projective Geometry. Oswald Veblen, Institute for Advanced Study. *Some Unsolved Problems of Theoretical Dynamics.* George D. Birkhoff, Harvard University. *Textile Research in the Interest of the Consumer.* Ruth O'Brien, U. S. Bureau of Home Economics.

September 25. The Historical Interpretation of Art and Literature. Halvan Koht, former Secretary of State of Norway. *Tuberculosis as the Chemist Sees It.* Florence B. Seibert. The Henry Phipps Institute. *Glaciation and Submarine Valleys.* Reginald A. Daly, Harvard University. *Advancing Frontiers of Nursing Education.* Isabel M. Stewart, Columbia University.

September 26. The Significance of Choline as a Dietary Factor. Charles H. Best, University of Toronto. *Virus Infection of the Mammalian Foetus.* Ernest W. Goodpasture, Vanderbilt University. *Nuclear Transformations.* Ernest O. Lawrence, University of California. *The Cosmical Abundance of the Elements,* Henry N. Russell, Princeton University.

The program of symposia and lectures will be followed immediately by an Academic Festival, September 27–29, the principal events of which will include an Alumni Assembly, a Service of Thanksgiving and Commemoration, a Reception of Delegates, a Festival Concert and a Convocation, at which honorary degrees will be conferred.

SPECIAL ARTICLES

THE AGGLUTINATION OF RED CELLS BY ALLANTOIC FLUID OF CHICK EMBRYOS INFECTED WITH INFLUENZA VIRUS

WHEN the allantoic fluid from chick embryos previously infected with strains of influenza A virus was being removed, it was noted that the red cells of the infected chick, coming from ruptured vessels, agglutinated in the allantoic fluid. Since red cells in the allantoic fluid of chick embryos inoculated with sterile materials did not agglutinate at all, it seemed that this agglutination phenomenon might be the result of infection with influenza virus in the chick.

To demonstrate the agglutination phenomenon in the infected chick embryos, the egg shell was opened over the air sac. The outer chorio-allantoic membrane was torn away, and several large blood vessels were purposely ruptured. Fifteen to 30 seconds were allowed for the embryo to bleed into the allantoic fluid before the contents of the allantoic sac were emptied into a petri dish. If the embryo had been infected with influenza virus, macroscopic agglutination of the red cells occurred within 15 to 30 seconds in the petri dish. If the agglutination did not appear promptly, it usually did not occur at all, and the differentiation between positive and negative eggs was easy. Virus titrations and serum neutralization tests were then set up in eggs, with this agglutination phenomenon as an index of infection. Egg-passage viruses and ferret sera were used in these tests. One tenth cc of the material was inoculated into the allantoic sac of 11-day old embryos which were then allowed to incubate for 3 days. The eggs were opened by the method described above, and positive and negative reactions were recorded. By using eggs in the same way that mice are used in serum titrations and virus titrations, it was found that serum neutralization tests and virus neutralization tests could be performed. The end points were as sharp as those obtained in the mouse test. The agglutination reaction worked equally well with strains of influenza A or B virus and with swine influenza virus. Cross neutralization tests were then set up with these viruses, which gave results consistent with the specificity of these strains as established in mice. A neutralization test with acute and convalescent serum from a case of influenza A demonstrated a rise in antibody titer in the convalescent serum which was consistent with the rise obtained in similar tests in mice.

Throat washings have been passed in eggs, and while this phase of the work is in a preliminary stage we have so far isolated two strains of influenza A virus directly from throat washings and obtained the agglutination phenomenon in the chick embryo on the second passage. The virus from these throat washings was set up in a neutralization test with A and B antiserum in

eggs and its identity as A virus was established. In one case the total elapsed time from inoculation of the throat washings until the confirmation of the identity of the virus by specific serum was only 9 days. Whether B virus and other as yet undescribed viruses from influenza cases will behave similarly is now being determined.

At present neither the mechanism of the agglutination phenomenon nor its specificity for influenza virus infection is well understood. However, the following facts have emerged:

(a) When infected allantoic fluid, either fresh or stored at −72° C. (from which the red cells had been removed by low-speed centrifugation), was mixed in a test tube with washed normal adult chick red cells, an agglutination phenomenon occurred. This *in vitro* agglutination was somewhat slower than the one previously described. Here a positive agglutination reaction was usually visible in 5 to 20 minutes. The red cells sedimented rapidly and formed a characteristic, ragged, granular pattern on the bottom of the tube. If red cells were added in the test tube to allantoic fluid from uninfected chicks, only the slow sedimentation of red cells occurred with no aggregation, and in settling out the cells formed a sharp round disk in the bottom of the tube. If the allantoic fluid from chicks infected with PR8 virus was diluted before adding the red cells, agglutination was still visible in a concentration of 1:512 (final concentration of allantoic fluid).

(b) When normal chick embryo red cells were added in sufficient numbers to allantoic fluid and allowed to settle out, over 99 per cent. of the virus disappeared from the supernatant fluid.

(c) When the allantoic fluid was centrifuged (45 minutes, 11,500 r.p.m.) the "titer" of the supernatant in terms of agglutinating capacity dropped approximately four times. This fall in agglutinating titer was consistent with the expected drop in virus titer as determined by previous tests in mice with the same fluid which showed that 70 to 90 per cent. of the virus was sedimented.

(d) If, instead of infected allantoic fluid, the supernatant from centrifuged ground mouse lung infected with PR8 mouse passage virus was used, the added red cells agglutinated in a dilution as high as 1:5000 (final concentration of mouse lung).

(e) When influenza A ferret antiserum (PR8) in dilutions as high as 1:1024 was mixed with allantoic fluid infected with the homologous virus, the agglutination phenomenon was inhibited. The inhibition was specific, that is, influenza B ferret antiserum in dilutions as low as 1:8 failed to inhibit the agglutination of red cells by fluids containing influenza A virus.

(f) Such inhibition also occurred with human serum, and in Table I is a titration of acute and convalescent serum from a proven case of influenza A. Dilutions of serum were mixed with a constant amount of W.S. infected allantoic fluid; then a constant amount of chick embryo red cell suspension was added, and the agglutination was read in 1 hour. The change of titer of this agglutination-inhibiting substance following infection is obvious and appears to be of the same order of magnitude as the rise in the patient's neutralizing titer against PR8 virus as determined in the mouse.

TABLE I

COMPARISON BETWEEN IN VITRO INHIBITION OF RED CELL AGGLUTINATION AND MOUSE NEUTRALIZATION TESTS WITH ACUTE PHASE AND CONVALESCENT SERUM FROM A CASE OF INFLUENZA A

Serum	Constant amount of infected allantoic fluid tested against various dilutions of serum*		Results of neutralization test in mice against uniform dose of virus†	
	Dilution of serum	Agglutination after 1 hour	No. died	No. survived
Acute	1:8	++	4	0
	1:16	++++		
	1:32	++++	4	0
	1:64	++++		
Convalescent ...	1:8	−	0	4
	1:16	−		
	1:32	−	0	4
	1:64	−		
	1:128	−	0	4
	1:256	−		
	1:512	+	3	1
	1:1024	+++		
Saline control, no virus		−		
Virus control, no serum		++++		

* The W.S. strain of influenza virus was used for the infection of chick embryos.
† The PR8 strain of influenza virus was used for the protection test in mice.

Such an *in vitro* test as shown in Table I will be of great advantage over the mouse neutralization tests if it can be shown that it measures influenza neutralizing antibodies. Our results so far suggest that the amount of agglutination-inhibiting substances in sera parallels the neutralizing antibody titer more closely than the complement-fixing titer. Whether this *in vitro* test will be sensitive and specific enough to replace the mouse protection method for determining serum neutralizing antibodies, is a problem at present under investigation. A more complete report will be published at a later date.

GEORGE K. HIRST
THE LABORATORIES OF THE INTERNATIONAL HEALTH DIVISION OF THE ROCKEFELLER FOUNDATION, NEW YORK

ON THE SPECIFIC ADSORPTION OF ALCOHOLS AT THE SALICYLALDEHYDE/WATER INTERFACE

DURING a recent investigation by one of us (D.F.C.) of the interfacial tensions between water and mixtures of isoamyl alcohol and salicylaldehyde, it was observed that, over a wide range of isoamyl

alcohol content, the interfacial tensions were so low as not to be measurable with the Du Noüy tensiometer. In order to study this phenomenon in another aspect, the E.M.F.s of the cell—

$$\text{Hg} \;\Big|\; \text{Hg}_2\text{Cl}_2 \;\Big|\; \begin{matrix}\text{0.0001 N. KCl}\\ \text{Salicylaldehyde (1)}\end{matrix} \;\Big|_{A_1}\; \text{Sat. KCl} \;\Big|_{B_1}\; \begin{matrix}\text{Sat. KCl}\\ \text{Salicylaldehyde (2)}\end{matrix} \;\Big|_{B_2}\; \text{0.0001 N. KCl} \;\Big|_{A_2}\; \text{Hg}_2\text{Cl}_2 \;\Big|\; \text{Hg}$$

—were investigated. Alcohols were titrated by means of a microburet into the oil phase (2). Precautions were taken to ensure proper mixing. The E.M.F.s were measured by means of an electrometer valve circuit and a compensating potentiometer.

A large series of alcohols was thus investigated. It was found that, in comparison with most primary normal alcohols, isobutyl and isoamyl alcohols caused a much larger initial drop in the E.M.F. curve, whereas secondary octyl alcohol showed a markedly smaller effect (see Fig. 1). The most surprising results of the investigation were, however, the larger effects shown in general by alcohols containing odd numbers of carbon atoms in the chain and the distinct specificity shown by normal heptyl and nonyl alcohols. The changes in the E.M.F. of the cell occasioned by the addition of 4 per cent. by volume of homologous primary normal alcohols to the oil phase (2) are shown in Fig. 2, where the E.M.F.s are plotted

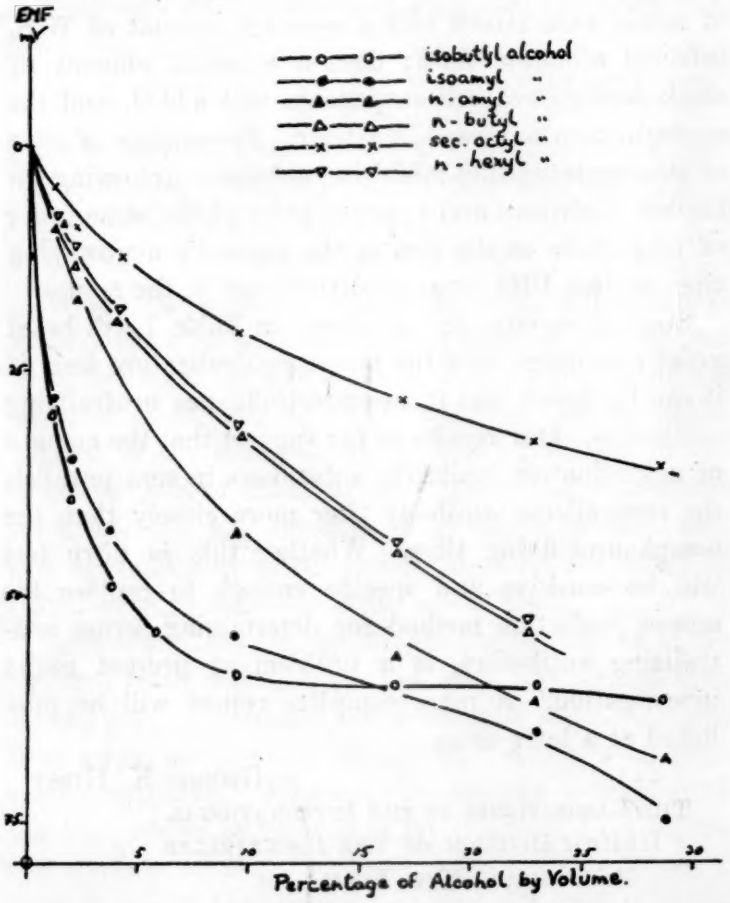

FIG. 1

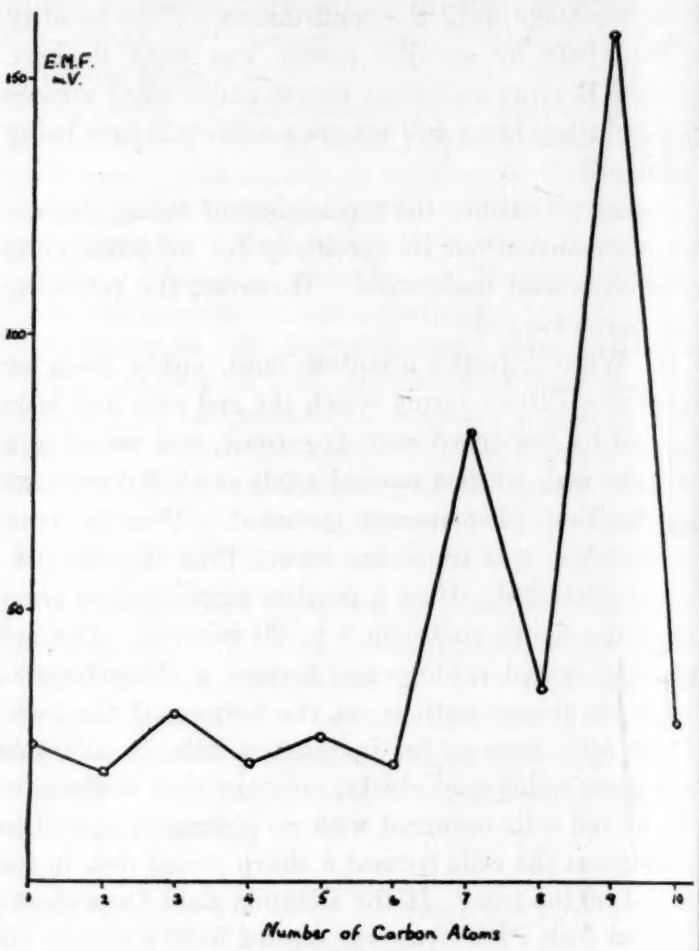

FIG. 2

against the numbers of carbon atoms in the alcohol chains. It will be observed that the heptyl and nonyl alcohols give effects several times greater than those of the other primary alcohols, while the nonyl effect is the greater of the two. The point X indicates the E.M.F. for a similar system containing secondary octyl alcohol, which differs from the heptyl alcohol by a methyl group in the l-position.

The primary alcohols benzyl and phenyl ethyl alcohols give effects of the same order of magnitude as those of most normal alcohols, whereas cyclohexanol gives a curve whose slope is much greater.

Measurements on the cell—

$$\text{Hg} \;\Big|\; \text{Hg}_2\text{Cl}_2 \;\Big|\; \begin{matrix}\text{Sat. KCl}\\ \text{Salicylaldehyde (1)}\end{matrix} \;\Big|\; \begin{matrix}\text{Salicylaldehyde}\\ \text{(2)}\end{matrix} \;\Big|\; \begin{matrix}\text{Sat. KCl}\\ \text{Hg}_2\text{Cl}_2\end{matrix} \;\Big|\; \text{Hg}$$

—indicated that the titration of alcohol into the oil phase (2), which was separated from (1) by either a porous membrane or a long diffusion path, caused only minor potential changes. In the original cell, therefore, the principal phase boundary effect must have been located at the interface A_2, the interfaces A_1, B_1 and B_2 being almost constant.

We have been led to the conclusion that the effect is due, directly or indirectly, to the interfacial adsorp-

tion of the alcohols at the salicylaldehyde/water interface. We consider that changes in the polar characteristics of the interfacial layer of salicylaldehyde molecules and water dipoles are induced by the alcohol molecules in accordance with their steric disposition. These changes at the A_2 interface will lead in turn to electrical asymmetry of the cell, due to different states of ionic distribution at the A_1 and A_2 interfaces. The salicylaldehyde/water interface may therefore be considered as having the properties of a specific receptor for alcohols with certain arrangements of the carbon chain.

The phenomena described above may conceivably lead to a clarification of certain selective phenomena in biological systems, such as, for example, the changes in the properties of local anesthetics caused by different carbon chain arrangements and the specificity shown by the olfactory chemoceptors.

Further observations are proceeding, and their results, together with a more detailed account of the above, will appear in the *Arkiv för Kemi,* Stockholm.

GÖSTA C. H. EHRENSVÄRD
DUDLEY F. CHEESMAN

DEPARTMENT OF BIOPHYSICS,
WENNER-GREN'S INSTITUTE FOR
EXPERIMENTAL BIOLOGY,
UNIVERSITY OF STOCKHOLM

EXPERIMENTAL VITAMIN P DEFICIENCY

RUSZNYÁK and Szent-Györgyi[1] were the first to find that flavones (citrine) behave like vitamins in man. The new vitamin was named P vitamin, because of its effect on the permeability of capillaries. Later Bentsáth, Rusznyák and Szent-Györgyi[2] found that scurvy in guinea-pigs is not only due to vitamin C deficiency, but is a mixture of deficiency in C and P vitamins. Zilva[3] could not confirm these later experiments, and Szent-Györgyi[4] did not succeed in reproducing them. Two years ago Zacho[5] showed that the diminution of capillary resistance in guinea-pig scurvy has no connection with a lack of ascorbic acid, and can only be made to cease with citrine. It seemed that with the help of a method based on this result vitamin P deficiency could be studied and the efficiency of various citrine preparations controlled. Our own experiments are in agreement with those of Zacho, and we succeeded in showing that those citrine preparations which have a therapeutic action in man, cause the diminished capillary resistance to disappear in the guinea-pig. As it appeared that the scurvy diet is not only deficient in ascorbic acid, but in flavones also, we have studied the effect of a scorbutogenic diet on rats. It is well known that the rat does not develop scurvy even on a diet lacking ascorbic acid. It appeared that under the influence of a scorbutogenic diet the rats did not, in fact, develop scurvy even after a long period of time, but their capillary resistance, measured with the Borbély method, diminished considerably in 5 to 6 weeks. When we gave such rats with diminished capillary resistance 3 to 4 mgm. of citrine per day subcutaneously, their capillary resistance became normal in 10 to 14 days. It became clear, therefore, that one can study vitamin P avitaminosis and control the efficiency of citrine preparations on guinea-pigs with scurvy and rats kept on a scorbutogenic diet. These animal experiments are in entire agreement with the results of Scarborough,[6] who has recently published observations which prove the occurrence of isolated P avitaminosis in man.

ST. RUSZNYÁK
A. BENKÓ

MEDICAL CLINIC,
SZEGED, HUNGARY,
MARCH 28, 1941

SCIENTIFIC APPARATUS AND LABORATORY METHODS

PREPARING NITRATE-FREE SEA WATER

IN the photometric or colorimetric determination of nitrate in sea water by the "reduced strychnine" method, nitrate-free sea water of the same chlorinity as the water being analyzed is required for the preparation of the standard solutions used in the estimation of the unknown solutions or calibration of the photometer.

Harvey[1] first mentioned the difficulty of obtaining nitrate-free sea water. However, he made the observation that surface water from the English Channel during the spring months usually contained less than ten microgram atoms of nitrate-nitrogen per liter. (A microgram atom is a millionth of a gram atom.) Riddell[2] also observed that at the time of extensive diatom flowering certain waters from the Georgia Straits were nitrate-free. Unfortunately, naturally occurring nitrate-free sea water is not always available when needed. Because of this sea water is often freed of nitrate by conversion of the nitrate to ammonia by boiling for several hours with amalgamated

[1] *Nature,* 138: 27, 1936.
[2] *Ibid.,* 138: 798, 1936; 139: 326, 1937.
[3] *Biochem. Jour.,* 31: 915, 1488, 1937.
[1] H. W. Harvey, *Jour. Mar. Biol. Asn. United Kingdom,* 14: 71–88, 1926.
[4] *Hoppe-Seylers Zeits.,* 255: 126, 1938.
[5] *Acta path. scand.,* 16: 1411, 1939.
[6] *Lancet,* 2: 644, 1940.
[2] W. A. Riddell, *Jour. Biol. Board Canada,* 2: 1–11, 1936.

zinc and sulfuric acid. This method introduces considerable quantities of $ZnSO_4$ and is somewhat uncertain.

A better method of freeing sea water of nitrate has been used by the authors in which the ability of certain pelagic plants, such as algae and diatoms, to extract nitrate from sea water, even when contained in glass bottles, has been utilized.

Samples of surface water were collected on August 1 from the bay at Friday Harbor, Washington, on an incoming tide. The plankton population at this time consisted largely of diatoms. Two-liter samples, contained in glass bottles, were placed where they would receive a maximum of diffuse light but little direct sunlight. The change in nitrate concentration was followed over a period of seventeen days, Table 1,

TABLE 1

REMOVAL OF NITRATE FROM SEA WATER BY PLANKTON*

μga PO_4–P per liter		μga NO_3–N per liter				
Days	0	4	9	12	14	17
1.65	39	39	37	15	2.3	0.0
3.00	27	22	22	15	0.6	0.5
3.50	66	72	68	33	20	1.6
4.00	70	68	73	40	29	6
4.50	32	23	13	7	6	..
5.00	44	44	47	30	6	0.0

* μga or microgram atom is equivalent to gram atom × 10^6.

using a modification of Harvey's reduced strychnine method.[3] Two or three ml samples of water that had been filtered through a Jena G-3 fritted-glass filter were mixed with an equal volume of reagent. The color was allowed to develop for three to five hours in the dark and then the white sediment was separated from the red solution by centrifugalization. The color estimations were made with the Zeiss-Pulfrich photometer using a variable cell depth of 1–10 mm and the S-53 color filter. The instrument had been calibrated against standard solutions of potassium nitrate in nitrate-free sea water of the same chlorinity.

No special control was exercised over the presence of animals or bacteria, the type of plants involved or the abnormal conditions of environment. These probably affected the rate of photosynthesis of the diatoms more than any small differences in concentration of nutrient salts. As shown in Table 1, the phosphate concentration was varied but had no effect on the rate of nitrate removal. The addition of plankton, collected from the bay with a hand net, accelerated the nitrate removal in general, although the nitrate concentration occasionally increased at first. Probably this was due to bacterial action on the plankton killed by removal from their natural habitat.

As soon as the samples became nitrate-free, the suspended organisms were removed by filtration and mercuric chloride was added to prevent the formation of nitrate through bacterial action on the dissolved albuminoidal nitrogen. Eight ml of saturated solution per liter of sea water was an effective amount and did not interfere with the subsequent determination of nitrate. The water was stored in paraffined bottles until used.

[3] H. W. Harvey, *Rapp. et Proc-Verb.*, 53: 68–74, 1929.

REX J. ROBINSON
BENJ. M. G. ZWICKER
OCEANOGRAPHIC LABORATORIES,
SEATTLE

SMOOTHING COLORS APPLIED BY COLORED PENCILS

BRANDON GROVE, of the Vacuum Oil Company, Madrid, Spain, described in the April 4 issue of SCIENCE a seemingly "new" method of smoothing colors applied by colored pencils. This method is so old in the U. S. Forest Service that I tried to determine its origin. As I have been in the Service only twenty-two years I went to our head draftsman, here in Missoula, Joe Halm. He could not tell me because—"When I started out coloring maps, *in 1912,* the old timers showed me how to use gasoline to smooth and fix the colors"! Standard rubbing pencils called "stomps" are obtainable from any draftsman's supply store which are absorbent and permit a much better job of gasoline smoothing than can be done with a cloth, as recommended by Mr. Grove.

Mr. Halm informed me that his CCC trainee-draftsmen, at the Nine Mile Camp, have recently discovered something that was new to him, however. The boys have found that the liquid used in Pyrene fire extinguishers is just as good and much cheaper than drug store or c.p. carbon tetrachloride for *removing* colors which for some reason have to be changed or eliminated. The commercial Pyrene fluid is also better than carbon tetrachloride for cleaning tracings which have been soiled in the process of inking. The Pyrene does not thin the India ink lines as much as c.p. carbon tetrachloride. After it has evaporated colored crayons and gasoline smoothing can be used without any thinning or weakening of the colors.

H. T. GISBORNE
NORTHERN ROCKY MOUNTAIN FOREST AND
RANGE EXPERIMENT STATION

BOOKS RECEIVED

BABCOCK, HARRIET. *Time and the Mind; Personal Tempo —The Key to Normal and Pathological Mental Conditions.* Pp. 304. Sci-Art Publishers.

KOLTHOFF, I. M. and J. J. LINGANE. *Polarography.* Pp. xvi + 510. 141 figures. Interscience Publishers. $6.00.

LEHMER, DERRICK H. *Guide to Tables in the Theory of Numbers; National Research Council Bulletin No. 105.* Pp. xiv + 177. The Council, Washington. $2.50.

O'HANLON, M. ELLEN. *Fundamentals of Plant Science.* Pp. xi + 488. 268 figures. Crofts. $4.25.